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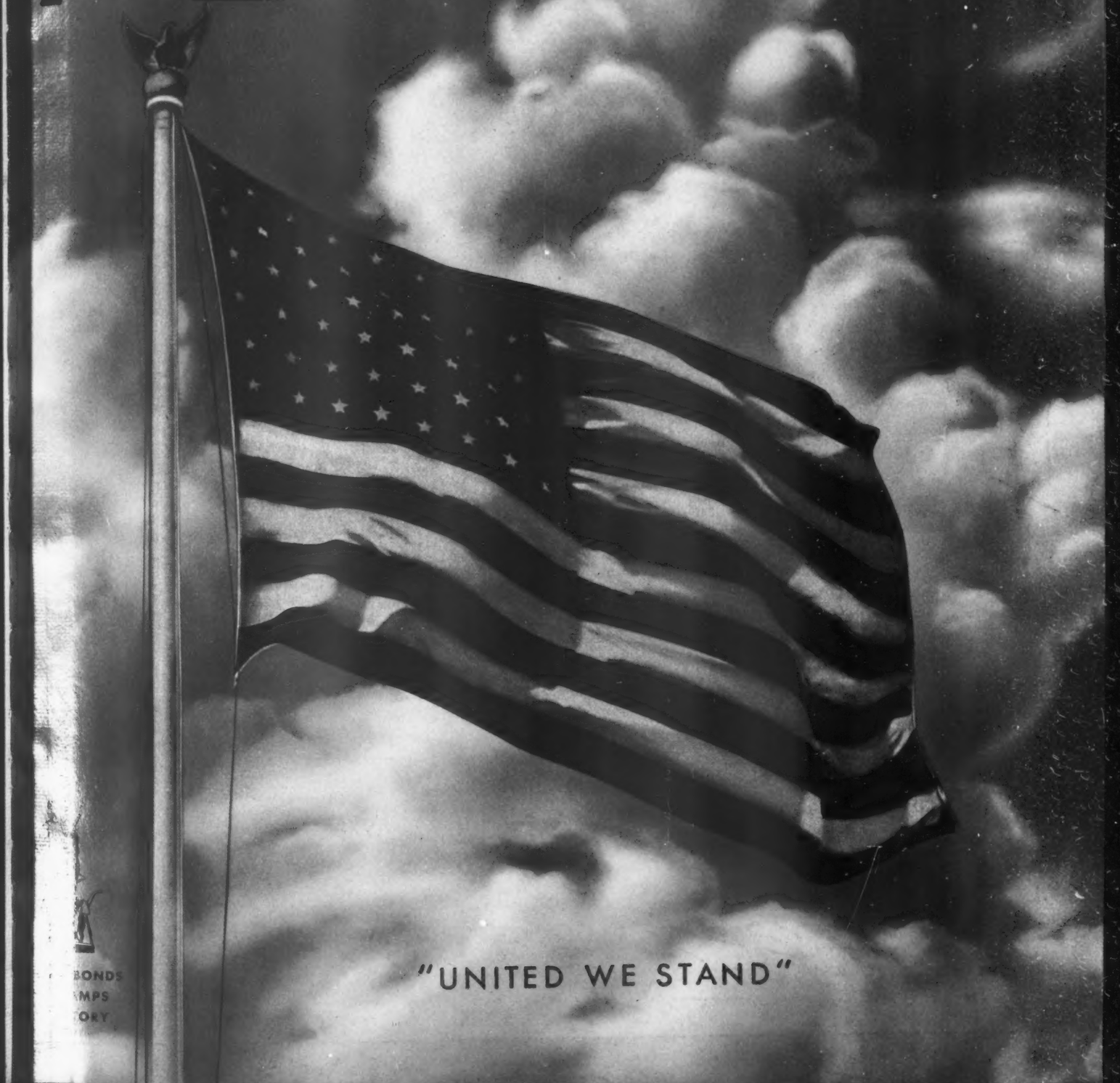

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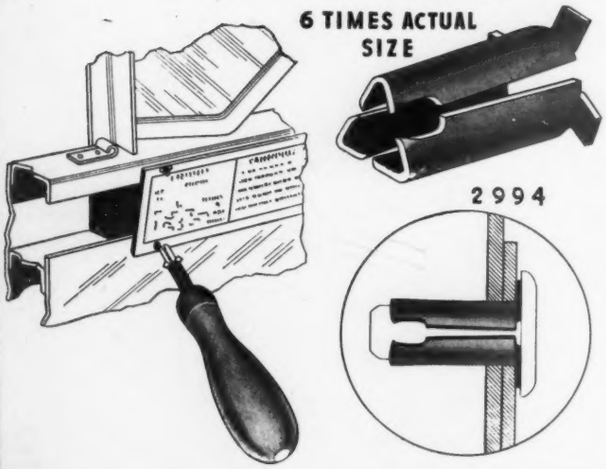

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AVIATION

NUMBER 7 VOLUME 41

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SETTING A COURSE FOR VICTORY

Flying a load of war to the enemy's back yard requires more than courage, decision and skill. Where distances are read in thousands of miles, slight deviation from course can mean a miss. And American pilots are not in the habit of missing objectives. Their navigation is precise. Their instruments have earned implicit trust.

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★ ★ IN THIS ISSUE ★ ★

WAR PRODUCTION is the theme of this issue. It's a big issue because it *has* to be if the theme is to be more than barely developed. The mass production of aircraft for war in this country is unquestionably the most stupendous accomplishment of the times.

It has been called a miracle—but it isn't. It is simply a combination of "know-how," tireless effort, and singleness of purpose. And, not to be overlooked, is the element of industrial cooperation that our enemies did not believe possible in a democracy, but which, by reason of the flexibility of democratic enterprise, is probably the biggest single contributing factor in the success of our production to defeat the enemy.

This issue is devoted to the "how" of these things.

Production performance to date seems remarkable, says the editor (page 81), but we can expect much more as floor space reaches the amount called for in our program, and as the materials shortages situation becomes easier. Looking beyond the immediate needs of war, there is especial significance in our production program when one thinks in terms of distribution of commodities and the future.

In line with our comments on industrial cooperation, the story of how one of the country's largest business machine companies cooperated with one of the largest aircraft producers to eliminate what might have been a serious production bottleneck, the release of engineering detail to the shop and establishment of production control, is told beginning on page 108.

How work simplification in existing plants can speed war production at least 50 percent without increased employee effort is explained by Allan H. Mogensen, authority on time and motion studies (page 116).

Maintaining fluidity of design and a high rate of production at the same time is an American specialty that is counting mightily against the Axis. How this is being accomplished at Lockheed is described in the story on the expediter system (page 122).

An important new development in the duplication of templates is the electro-etching process originated at Northrop Aircraft Inc. This valuable contribution to greater mass production of aircraft is described in detail starting on page 142.

How a maker of aircraft engine parts is recruiting unskilled labor, and through a planned program is converting it to skilled labor with good result, thereby overcoming a serious production bottleneck, is described on page 130.

On page 148 is a story telling how Buick is handling material flow in its aircraft engine factory, a problem which is complicated by varying sources of material supply and the need for particular care in handling precision parts.

There are a number of other important articles relating to production methods as well as the ever-useful feature articles of interest to design and research engineers.

In addition there is a report from AVIATION's British correspondent on the training of RAF maintenance personnel to handle American equipment (page 94), a continuation of Capt. Courtney's article on water based airplanes (page 91), and more interesting data on the Anderson Forming-by-Drawing process (page 162).

A large measure of the progress in mass production of aircraft can be traced to the efforts of the engineering societies in this country. An important joint meeting of the Society of Automotive Engineers and the Detroit Engineering Society, at which T. P. Wright, assistant chief of Aircraft Branch of WPB, and Col. Arthur W. Herrington, SAE president, were two principal speakers, is described on page 104.

DAVID G. FORMAN, assistant to the president, and director of Visual Training at Bell Aircraft Corp. describes on page 127 his company's program for training the assembly line worker quickly and efficiently by means of carefully produced and arranged sequence photographs of assembly operations. This method of visual training puts the inexperienced worker on the line quickly with confidence and "know-how."

J. M. GWINN, JR., supervisor of tools and methods at Consolidated Aircraft Corp. describes (page 98) one of the best examples of the productive ability of this country—turning out heavy bombers in quantity. The Consolidated B-24 is one of this country's "super heavies" with which the United Nations intend to blast the way to Victory. How these gigantic war machines are rolled off the assembly line in huge numbers is graphically told in Mr. Gwinn's article.

The Maintenance Section includes a story of wartime activities at United Air Lines' great Cheyenne overhaul base, and a description of the Technical Training Command's maintenance program. In the Military Section, Fred Lamoreux talks of Hitler's latest weapon against convoys.

Coming

Among the articles to appear in the August issue of AVIATION will be one on the importance of weight control in airline operations. There will also be an article on the meteorological characteristics of thunderstorms based on a recent study by a member of the U. S. Weather Bureau. The analysis of structure, spacing, and general behavior of thunderstorms will be of real interest to operators.

AVIATION's British correspondent will continue his first-hand observations of American fighting planes in action in Europe. An informative article on CAP operations will also appear in the August issue. In addition there will be a host of other features in AVIATION's regular departments.

OUR APOLOGIES, LIEUTENANT!

THOSE weren't ordinary tires you were brake-testing on that bomber, but U. S. Royals with new block tread. We feel sorry as anything about those missing front teeth.

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Production, Distribution and the Future

TWO YEARS HAVE PASSED since the President called for 50,000 airplanes and as this War Production Issue of AVIATION is being prepared, we are assured by Undersecretary of War Patterson that we will exceed, by a wide margin, a subsequent Presidential request for 60,000 planes this year. This performance is even more remarkable when we realize that the procurement program is heavily loaded with long-range bombers of the type that are playing such an important part in reducing the striking power of the Japanese fleet.

Remarkable as this production performance seems it has been accomplished with a comparatively small part of the total productive floor space provided in the program. As this is written there are a number of our largest plants about to go into active production, and a number of others still being built. With this new capacity we should have no difficulty in doubling production next year and eventually tripling output, provided the problems of material and equipment shortage are solved. It is hoped that the contributions of our aircraft to our recent victories have convinced our strategists that they have no more important job than the solution of the problems of these shortages.

With production well in hand, we turn logically to distribution. Fortunately, there are many types of aircraft which can be flown across the oceans. Some are able to drop off bombs along the way and we may expect more Doolittle deliveries in the future. But some airplanes and many commodities must be delivered by other means. This is being done with reasonable safety over our arterial convoy routes. But it isn't being done in some other places. And that leads us to another strategic mistake in this war—the failure to provide a sufficient number of plain ordinary cargo planes by a nation which led the world in air transport. At long last, we are getting action on this front, but this action should have been taken in 1938 when returning observers reported that Germany was building huge numbers of Junkers transports without windows or seats.

Within the framework of our limitations we are moving great quantities of war material and equipment by air right now and out of these worldwide transport operations are developing the pattern of tomorrow's trade routes. Already the acceleration of world air transport development has brought us to a point that might have required a decade or more of peacetime progress. This is one of the redeeming features of the war.

The post-war period will see an even greater shrinkage of the world in terms of time. No longer will it require weeks or months to reach some of the more remote portions of the globe. No longer will seaports be the determining factors in the prosperity of cities. The new equality of opportunity for communities will result in a desirable decentralization of population, in a new migration inland. The vehicles will not be wagon trains. They may be glider trains.

The tempo of communications will be stepped up by air mail and express service to every hamlet that can afford a pick-up system consisting of a pair of poles, a cable and a 100 feet square of open space. The same pick-up planes will be used to carry local passengers between the larger towns with airports.

For home use in the world of tomorrow, we will have roadable family aircraft, probably of the rotary wing type. Fixed wing aircraft with simplified control and new safety devices now under development will be available for family cruising between airports. Bad weather will not be as great a hazard as it has been.

All these things and more will be ready for the post-war world. But that world must so be organized that no man or nation dare misuse the gift of flight as it is being misused now. This too, can and must be accomplished by properly directed air power.

Leslie E. Neville

AMERICA AT WAR

With the RAF's massive air assaults on Nazi industrial nerve centers, and Allied Armies holding in Russia and Egypt as the United States production machine snarls into high gear, new vigor and optimism pervade in high councils of United Nations.

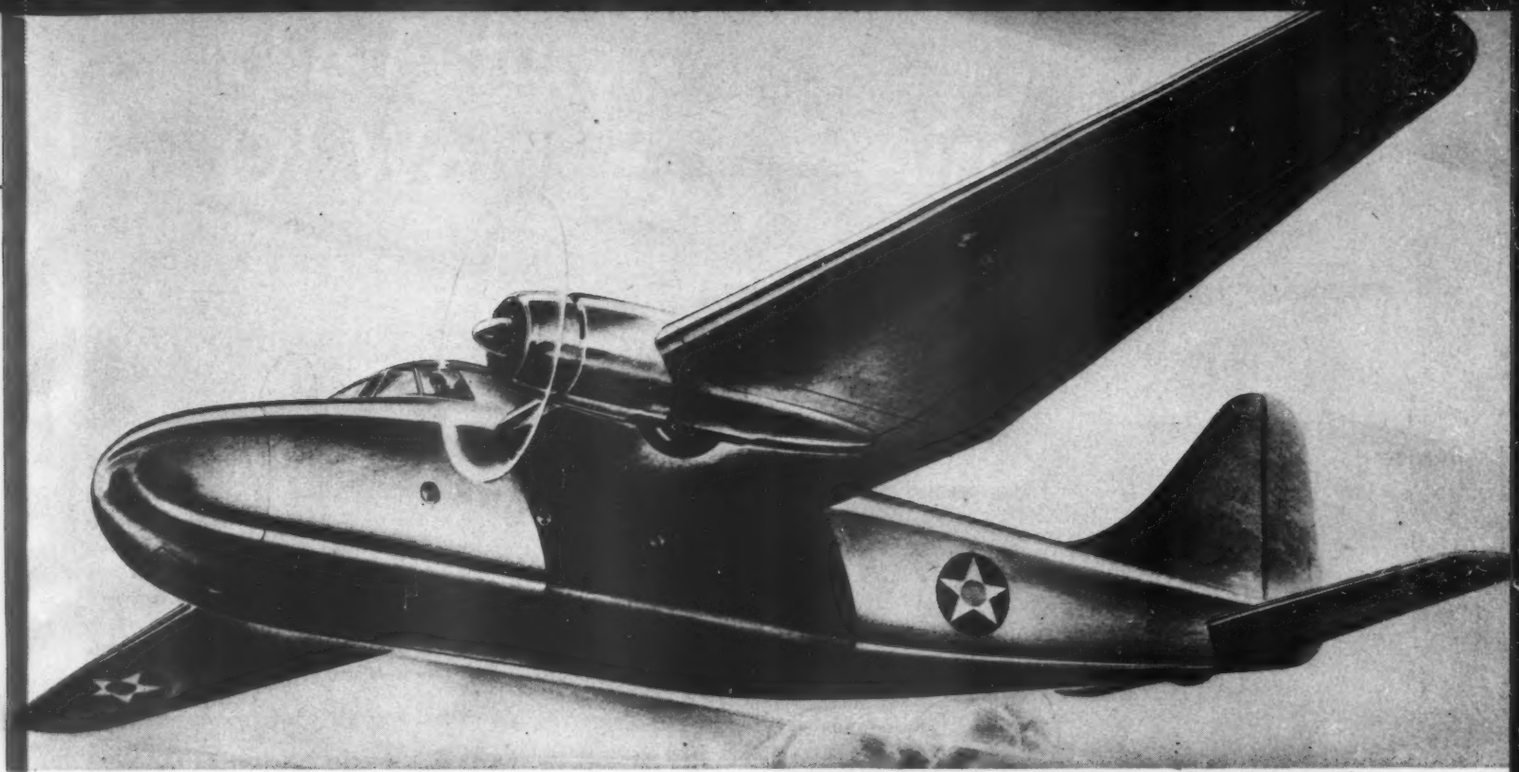
DEVELOPMENTS ARE COMING thick and fast in the world air war. United Nations retain superiority on the Russian and Australian fronts; the Japanese have lost the upper hand elsewhere in the Pacific; and Britain and the United States are wielding destruction over Europe against futile Nazi opposition. Jump-off spots for the bombing of Japan are now in sight. A vast movement of war cargo and troops by air is an early probability. For the first time since September 1, 1939, the defeat of the Axis can be visualized in terms of power and not hope alone. Now, the United Nations can demonstrate staggering air power.

Foremost united achievement of late is RAF's bomb punches at German war centers, which are rocking Hitler on his heels. One night in late May the English went over the Channel with 1,000 bombers and 250 defensive fighters and dropped six million pounds of bombs on Cologne. Pilots in the raid said the city was substantially destroyed.

The Germans themselves admitted the damage was "great," and this is not hard to believe, when one considers that the heaviest jobs the Luftwaffe ever did on England totaled around one and a half million pounds or less. And in addition, the British are now using a new bomb, weighing in

Glider trains may be a common sight soon. These are flown by Marines training at Parris Island. Army experts say the carrying capacity of twin-engine airliners could be doubled by glider tows and a program to train "many thousands" of glider pilots is under way.

International News Photos



International News Photo

Giant cargo planes in huge quantities open new horizons for mobility in modern warfare. Sketch shows the new transport to be built on a quantity basis by Curtiss-Wright Corporation of wood and other non-strategic materials.

excess of 4,000 lb. which they say demolishes a block with one hit.

But much worse for the Nazis is still to come. The English are trying to muster enough air force to average 1,000 planes a night over Europe. Counting bad weather nights when they couldn't go, this might call for as many as 3,000 on some occasions.

To put 3,000 bombers over Hitler's Europe, according to estimates quoted by the *British Press Service* in New York, would require 120 airdromes. This need could be met, it says.

The four-engine machines, such as the *Lancaster, Stirling,* and *Halifax* carry a crew of seven, and the two-engine ships, five each. Thus, 3,000 bombers would carry a total of 18,000 pilots and crews. At the rate of 20 men on the ground for each man in the air, a "heavy" night would occupy 350,000 to 400,000 men. This would be a colossal task of organization and coordination.

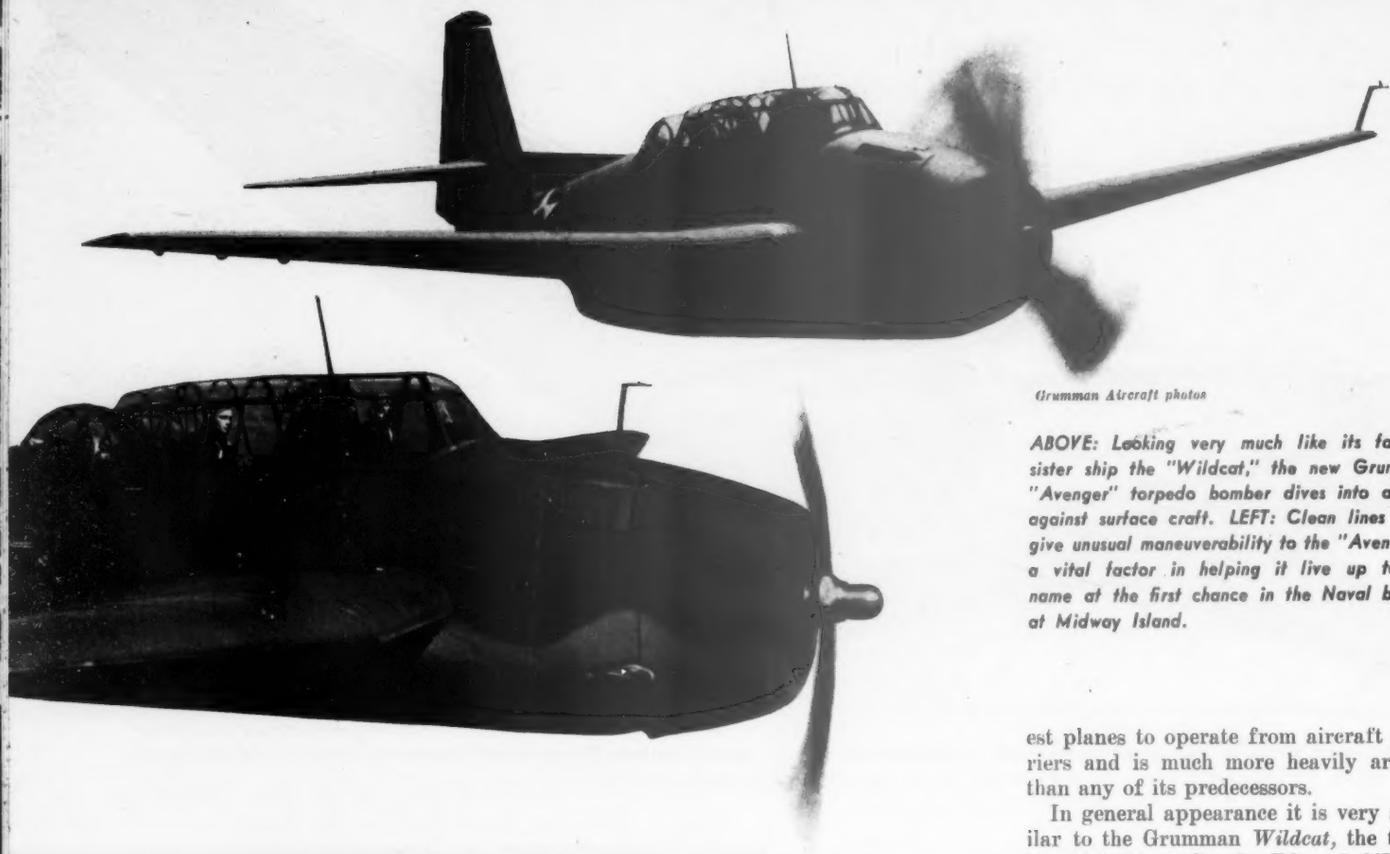
The matter of timing the take-offs of so many units from all parts of England to arrive over their targets at set times would be even more difficult. But it probably can be done, because it was done to a nicety with a third as many men when Cologne was hit.

Actual tonnage of bomb loads, of course, is the key fact, not the mere number of airplanes. One *Stirling,* for example, can carry as great a load as a whole squadron of Blenheims. A twin-engine bomber requires nearly as many men in the air and on the ground, as a four-engine plane but the load and range of the latter is proportionately much greater. The present proportion of two- to four-engine bombers gives

(*Turn to page* 287)

Brig.-Gen. J. H. "Jimmy" Doolittle finally was revealed as the leader of AAF's raid on Japan when President Roosevelt congratulated him on his exploit at the White House. He wears the Congressional Medal of Honor awarded him in recognition of his accomplishment. Looking on are Mrs. Doolittle and Lieut.-Gen. Henry H. Arnold, Chief of the Army Air Forces, who shortly thereafter flew to London to prepare the way for AAF's participation in the opening of a "second front" in Europe.

Wide World



Grumman Aircraft photos

ABOVE: Looking very much like its famous sister ship the "Wildcat," the new Grumman "Avenger" torpedo bomber dives into action against surface craft. LEFT: Clean lines help give unusual maneuverability to the "Avenger," a vital factor in helping it live up to its name at the first chance in the Naval battle at Midway Island.

Navy's "Avenger" Lives Up to Name

New Grumman torpedo bomber plays vital role in handing Japs painful surprise at Midway

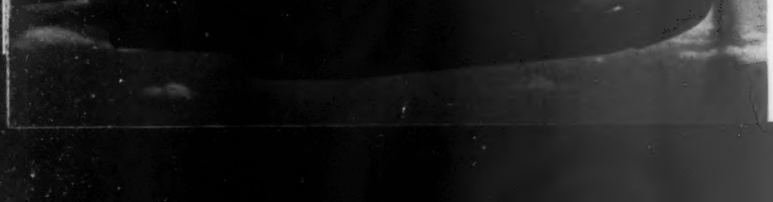
THE NAVY'S NEWEST and most deadly aerial weapon, the Grumman *Avenger* torpedo bomber, lived up to its name at the first opportunity in the Midway Island Naval battle, for planes of this type were credited with a large portion of the success of this action.

This new craft, manufactured by the Grumman Aircraft Engineering Corporation, fires regulation torpedoes from low altitudes at close range where marksmanship is most accurate. Carrying the torpedo entirely enclosed within the fuselage, the *Avenger* is one of the largest planes to operate from aircraft carriers and is much more heavily armed than any of its predecessors.

In general appearance it is very similar to the Grumman *Wildcat,* the type in which Lieut.-Comdr. Edward O'Hare shot down six Japanese craft in a single engagement. Also a mid-wing monoplane, the *Avenger* might easily be taken for a *Wildcat* at a distance, its lines giving no indication of its large crew and load carrying capacity. Credited with close-to-fighter performance, the *Avenger's* unusual maneuverability also helps conceal its mission.

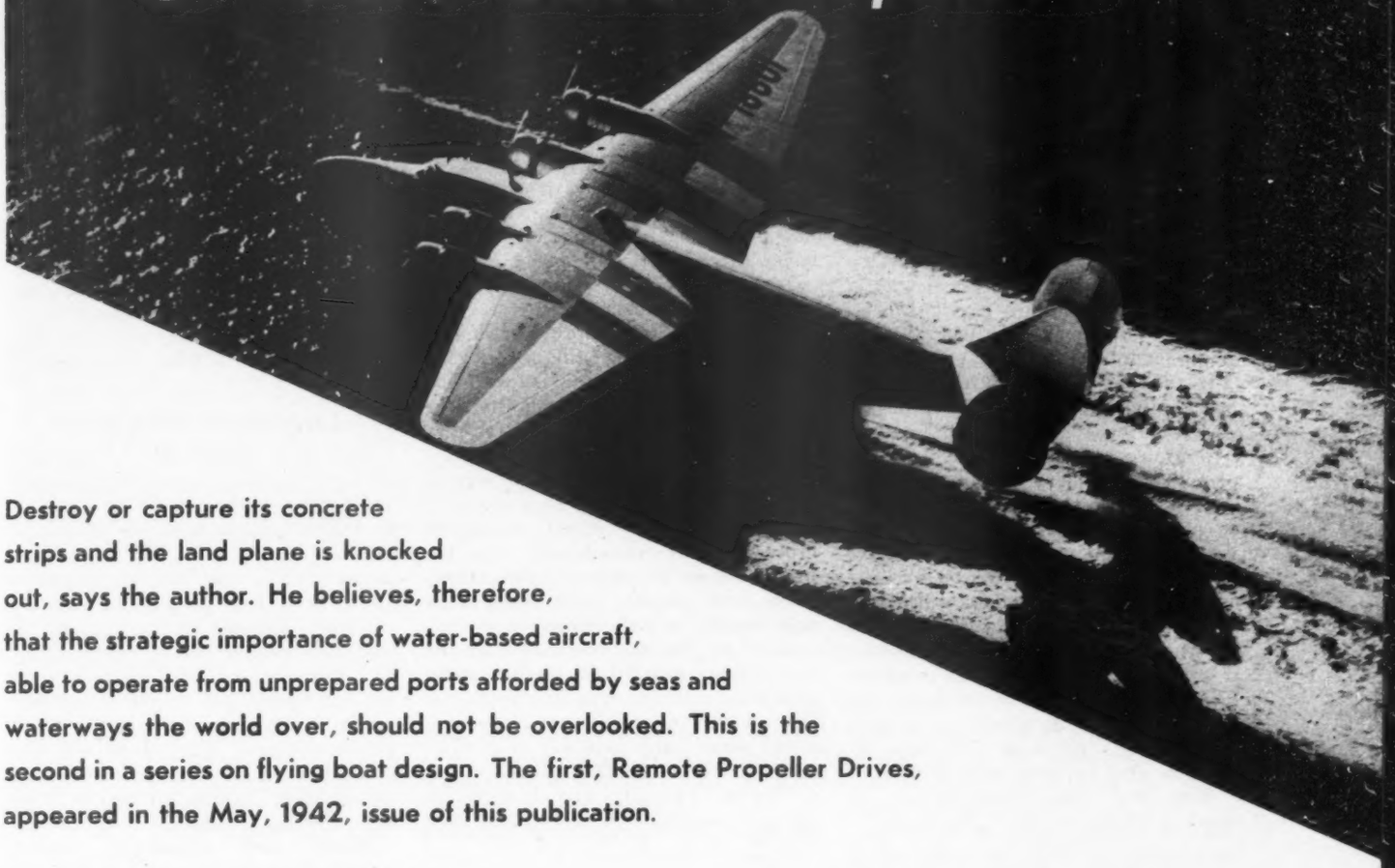
Design studies of high performance torpedo planes have been under way at Grumman for several years. Sensing the trend of Naval strategy, and in cooperation with the Bureau of Aeronautics, the company last year began construction. So confident were officials of the results that a production program was inaugurated simultaneously with flight testing of the first plane. The schedule was carried out quietly and, as a result, several Navy squadrons are already equipped and steady production has been established.

The Navy's newest and most deadly aerial weapon carries a regulation torpedo completely hidden within the fuselage, helping to give it near-fighter performance.



The new "Avenger" is one of the largest airplanes to operate from aircraft carriers and carries much heavier armament than any of its predecessors.

The Future Of Water-Based Airplanes



Destroy or capture its concrete strips and the land plane is knocked out, says the author. He believes, therefore, that the strategic importance of water-based aircraft, able to operate from unprepared ports afforded by seas and waterways the world over, should not be overlooked. This is the second in a series on flying boat design. The first, Remote Propeller Drives, appeared in the May, 1942, issue of this publication.

By CAPT. FRANK T. COURTNEY

The Boeing "Clippers" operated by Pan American Airways have for years shuttled back and forth across the Atlantic, carrying passengers, mail and express in peace and in war, without a serious incident. These 42-ton craft of great load-carrying ability are regarded as "midgets" compared to the large air carriers to come.

AS SOON AS the present war really got started, during the campaign in Norway, one fact of vital importance to aviation suddenly stood out—even if not many people saw it standing out: Norway was a walkover for the Germans because they seized all the airports, and the British had no airports—or so they said—on which to base fighters to protect their bombers, their Navy and their troops. Yet in fact Norway possesses hundreds of square miles of airports which the Germans could never have effectively controlled or destroyed; they are called fjords.

But the British had no airplanes capable of using them because, like everyone else, they had developed their airplanes to operate from smooth stretches of land.

Then came the battles of the Aegean, Greece and Crete. Again there were hundreds of square miles of water airports; but the Germans took Crete by taking first the only land airport there; no defending airplanes existed which could use the water, and the nearest land runways were in faraway Egypt.

And now the Pacific! A hundred airports within fighter range of all those places which we lost to the enemy "for lack of fighter support," airports far too numerous to be knocked out by the enemy, airports readily supplied by any sort of shipping, airports forming a line of stepping stones for replacements and reinforcements!

But all of them were airports for which we had no airplanes because, except for large, slow patrol boats, our airplanes can only operate from long smooth plots of land, laboriously prepared and supplied.

One may ask: why didn't we put the landplanes on floats and then use these water airports? Partly because, by such a makeshift, the performance of those landplanes is reduced below the point of real usefulness, but even more importantly because in neglecting the development of effective waterplanes, we have also neglected the development of the means and methods for their supply, maintenance and tactical employment. In brief, we have become utterly landplane-minded.

For this fact a powerful maritime nation has little excuse. But if this attitude is proving costly at present it will prove catastrophic if persisted in for the future. As surface navies struggle with increasing difficulty for survival against the airplane, supremacy over the coasts and seas of the world commences to pass to those who will have the air navies; and such air navies will have little aggressive power if confined to prepared patches of their own territory, or such similar patches of the enemy's territory as they may hope to capture in usable condition. It is impossible reasonably to suppose that great air navies will be effective which will be unable to use as bases the vast areas of water, inland, coastal and oceanic, of the globe; it is equally certain that such water-going airplanes are

not going to be effective if they are always expected to pay a high price in performance for their ability to use the water.

There is no reason why they *should* be inferior in performance to the landplane; there is no reason why water-based airplanes in all categories, from fighters to the largest bombers and transports, should not have a performance equal to that of landplanes—maybe slightly worse in some cases, slightly better in others. The reason why they are now inferior in performance is a technical accident which has thrown almost all development in the direction of the landplane.

It will not be easy thus to develop the waterplane, since it will probably always involve more complicated design problems than those of the landplane, and it will necessarily be a considerably different type of craft; it will be none the easier for the fact that years of comparative neglect will have to be made up. But it must be done—and if we don't do it others will.

These notes are an attempt to survey the situation historically and technically, if somewhat incompletely, as it affects the military and naval outlook; the commercial outlook, which has hitherto governed this situation, will now depend on what happens in those fields.

Why call them "waterplanes" instead of "flying boats." The reason is a strong one because the latter term has now come to mean a craft which is a boat first and an airplane second; it has come to mean a large, bulky, slow aircraft which, however good a *flying boat* it may be, is a poorly performing *airplane* by comparison with the corresponding landplane. Even most flying boat enthusiasts are now almost resigned to accepting this inferior performance, for which they try and point out compensating advantages; but the fact remains that it is the *airplane* we want.

The flying boat, as we now know it, has done and is doing good work. In some of its recently improved forms it is likely to be doing still better work because, before this war is over, the need for water-going airplanes will be so obvious that even their relatively low performance will have to be ignored—and they are all we have in the way of waterplanes. Moreover, even if, as I fully believe, the eventual waterplane types will differ considerably from the present types in general layout, experience with present flying boats must bulk largely in their design.

Even so, the fact remains that the term "flying boat," now fundamentally associated with one type of airplane of inferior performance, is not to be used where water-going *airplanes* in all categories is the point under discussion.

"Marine aircraft" and "seaplanes" are also unsuitable terms because they immediately introduce the open-sea association which is only a specific application of the waterplane's work; it is as though all landplanes were called "stratoliners."

In the early days of flying the term "waterplanes" was often used as a distinction from "landplanes." It seems reasonable to revive it, and I shall use it henceforth in these notes to designate a craft which, designed primarily as an airplane, uses water as the medium for leaving and returning to the surface. The questions as to how smooth this surface will have to be or how rough it may be are not a matter for snap judgments—they are a part of the general discussion.

Landplanes vs. Flying Boats

For years, on and off, the argument of the flying boat versus the landplane has been publicly aired. It would be too long a business to review the various cross-arguments here. It is sufficient to say that, as time goes by, the claims of the flying boat people are, one after the other, knocked on the head by the landplane people, not by argument but by actual performance. In fact, about the only point left to the flying boat people is the claim that, if only planes are built *bigger*, flying boats will beat landplanes—a most unsatisfactory form of argument because, so far, it is not clear how big is bigger.

Mostly such arguments revolved around the relative merits of the two types as commercial transports and, on that basis, they were fair enough as far as they went. The airline operator's view was a narrow one: he failed mostly to see that the "efficiency" of the landplane was not so much that of the airplane as of the prepared bases from which it operated; but so long as he was provided with such land bases, and so long as the resultant landplanes performed better than the boats (which he was glad to use when there were no prepared bases) and, further, so long as he was left to believe that a landplane performs better because it is a landplane, he is not to be blamed for discarding the boat.

These Consolidated PBY-5 Patrol Bombers, called the "Catalinas," have made an impressive record with the U. S. Navy and the British in this war. With a range of about 4,000 mi. and a sturdy hull, this plane requires no carefully prepared and elaborately paved areas of the earth's surface for sustained operations.

Photo by Rudy Arnold

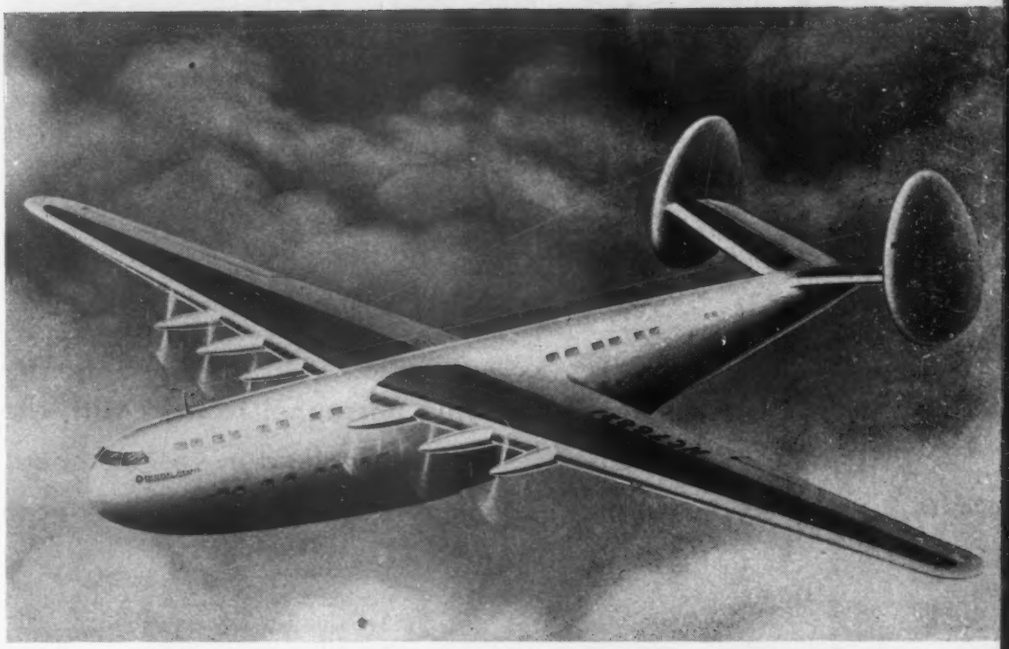
Peacetime military viewpoints closely paralleled the commercial outlook: one could aways get faster and faster landplanes by building longer, wider and thicker concrete runways—so long as you were building them on your own territory and had no enemy to smash them up or capture them, or so long as you could count on being able to use similar runways in peaceful foreign parts. It was a much easier process than trying to solve the many difficult problems connected with the design and operation of waterplanes.

Thus these debates on landplanes versus flying boats were regretable since they led to a competitive situation between the two classes: should we have one *or* the other? No situation arose where the need for *both* was obvious and, since the landplane was the easier from almost every standpoint, almost all major development efforts were spent in the landplane direction. The water-based airplane remained the boat-which-flew, and had to take such profit as it could from landplane development.

So "airplane" has come to mean "landplane," "airplane development" means "landplane development," and a flying boat or seaplane is a landplane adapted as best it can be to water conditions.

It is a useful approach to the problems concerned if one considers—and one must do so seriously—what would have been the situation if the reverse had occurred, which might well have happened under different social conditions. Let us suppose that, for some reason or other, the airplane had developed as essentially a water-going craft. We should have adapted, adopted or segregated existing water surfaces for airports. Where these were not available we should have built water runways as we now build land runways —which would have been a pretty similar undertaking. For coastal areas and areas with many large water surfaces the forced-landing and alternative airport problem would be highly simplified —*and this would have been an immense military advantage, as the returning night-bomber has tragically discovered;* for, whatever the problems of rough-water take-off may turn out to be, it will always be a relatively easy matter to get down safely on almost any sort of rough water. We should have developed and taken as normal, methods of servicing, handling, maintaining and refueling which might even have been simpler than our present ones. But the principal point I want to make here is that our *airplanes would have had about the same performance as they have now,* because we would have developed them to suit the surface medium from which they operated.

For service in areas where water surfaces could not be provided we should have adapted our waterplanes by fitting wheels to them and using them as landplanes—and we should have moaned about the inferiority of the landplane because of this extra weight. Then perhaps, in campaigns in large areas where there were no large water spaces available, we might have complained about the lack of landplane development—although it will always be the case that a waterplane can always be more readily adapted to land use than a landplane can be adapted to water.



Further indicative of the current trend in design of large "waterplanes" is the first released picture of the Glenn L. Martin Company's proposed 250,000-lb. flying boat. Glenn L. Martin states it will be able to carry 102 passengers each with 80 lb. of baggage, plus 25,000 lb. of mail and cargo to London in 13 hr. As military transports, such planes could carry large numbers of troops and heavy supplies.

Such a situation never arose; it was never likely to. I mention it only to incite a change in mental attitude to the *possibilities* of the waterplane. The need for waterplane development will be forced by two main factors: the lessons of the present war and the limitations which will arise in landplanes and their bases from extremely large sizes. The latter case might be taken care of, to an adequate if not an optimum extent, by direct development on lines of present flying boats—which still leaves us to get "landplane performance" out of the smaller categories and hence to develop waterplanes on distinctive lines of their own.

Why the Waterplane Has Not Progressed

It must not be assumed that failure of the waterplane to keep pace with the landplane in performance is due to any inevitable inferiority. There are many reasons which, added together, amount to one of those accidents of progress such as happen in many branches of engineering.

An analogous case is that of the aircooled radial engine as compared with the liquid cooled in-line. As far as this country was concerned, the latter had died, for all practical purposes, with the precarious 730 hp. of the Curtiss *Conqueror* of 1932 or thereabouts. Only for its survival and development in Europe it would probably never have been heard of again; whereas now a standard argument is whether it is or is not better than the aircooled radial (the answer to the argument being, of course, that each is the better in the job to which it is better suited). If there had been only aircooled radials or only liquid cooled in-line engines the powers available would have been just about the same as they are today—principally because the basic factors are pretty much the same. The same applies to the relative performances of landplanes and waterplanes.

Here are some of the principal reasons for the neglect of the development of the high-performance waterplane: First and foremost, the development of the landplane has been easier; the turning of a wheel on smooth ground is essentially simpler than the complexities of hydroplaning, and most people who can push a car out of a garage would not know how to launch or handle a boat.

(*Turn to page* 288)

American Aircraft Training In the RAF

The British have set up elaborate centers for preparing RAF maintenance and flying personnel to work with the American airplanes flowing to England in vast numbers. Mr. Cave also continues his observations of American aircraft at war in this article.

By MYLES C. CAVE, *"Aviation's" British Correspondent*

DESPITE AMERICA'S heavy responsibilities in the Pacific zone, large numbers of United States airplanes are still arriving in this country, and although great credit must be given to United States industry, the real handout must go to the Allied Merchant Navy.

New types are being introduced into the RAF with a lot less delay than previously, and the three pursuits, *Mustang, Lightning,* and *Airacobra* are going into squadrons in ever-increasing numbers.

American airplanes have naturally been quite a problem to British officials for, like British machines, there are always modifications to be made as the result of fighting experience. With home-produced ships this problem is comparatively easy to overcome when the parent firm is on the doorstep with trained personnel available. When the parent firm is up to 7,000 mi. away there are only a limited number of expert service engineers available, so there is liable to be long delay in getting new types up to front line pitch.

Recently the Ministry of Information gave newspaper men a break, allowing them the chance to look over a large RAF depot used exclusively for training instructors on American products, overhaul and repair United States airplanes, motors, radio and instruments. In addition the depot has created special facilities for instructing both civilian and RAF staff to American aviation practice. From a small group of experts used as instructors an organization has grown with semi-skilled and automobile service station hands which is handling complicated aero-mechanisms and assemblies with 100 percent results.

The whole organization was impressive in size and efficiency, and to an American like taking a quick trip back home. There were only two British aircraft, and these old types used for urgent transportation of parts and equipment when the need arose.

It is interesting to know that the original building forming this training school was built from the early packing cases from the ex-French *Maryland* bombers and erected by Polish labor. From those early days buildings have sprung up over a very large area, and now house many self-contained sections,

A Pratt & Whitney "Wasp" is the subject under discussion in this RAF school session.

such as airplanes, motors, propellers, radio, instruments, etc.

This British-American depot is staffed mainly by British engineers, though an engineer from each of the large American aircraft corporations is permanently stationed there and is responsible for any technical problems concerning their own company's products, and also for giving advice regarding instructions classes which are held both for civilian and RAF personnel.

In forming such an organization the Ministry of Aircraft production had to face difficult personnel problems—expert technicians in all fields were required on British airplanes, and, naturally, under such circumstances only a limited number of men were available for initiating training work on American products. It would have been normal to figure that the authorities would take the view that British airplanes and equipment should come first, but it must be handed to the Ministry of Aircraft Production when they took the opposite line in diverting some of their best men to the servicing and instructing of RAF engineers in the technique of American aircraft practice.

Aeronautical engineering and procedure differs greatly in Britain and United States, and, taking the inspection side alone, staff have had to get acquainted with different thread forms, material, specifications and methods of construction which in many instances do not conform to the usual Air Ministry requirements. Motor and radio design differ widely from British standards and such differences are liable to cause adverse comment under arduous service conditions if the technicalities of equipment are not adequately understood and correctly serviced.

Apart from minor criticism during the early months when all kinds of United States airplanes and equipment were pouring into squadrons and technical facilities stretched to the limit, there have been no adverse remarks due to the speed with which the RAF service set-up has organized. Right through, American products have received top attention.

As the war goes on and greater ini-

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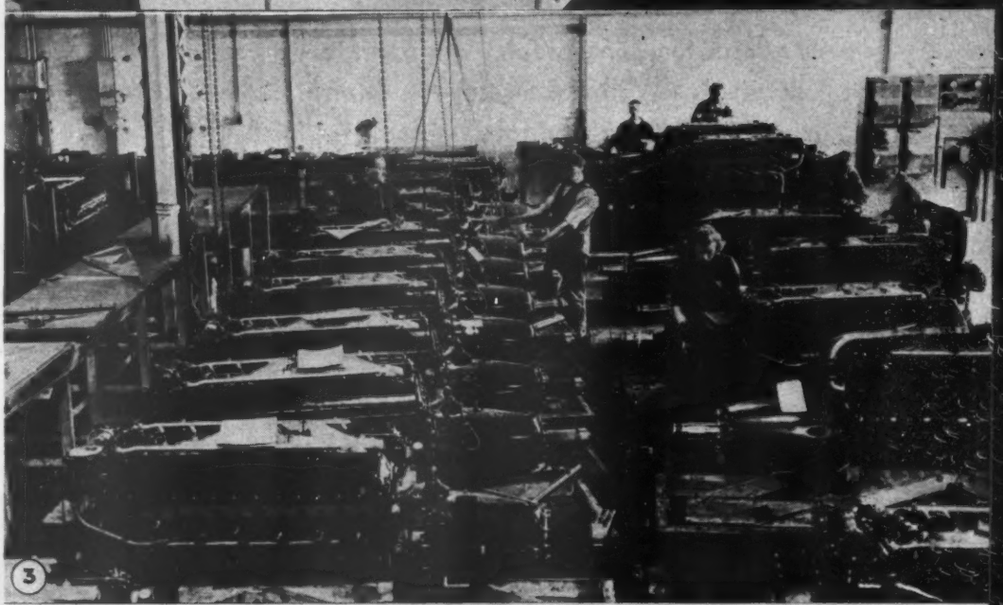

FIG. 1. RAF maintenance personnel at school to become familiar with the characteristics of American equipment. Here the Douglas hydraulic system is being explained. FIG. 2. RAF maintenance personnel get a lecture on the control system of the North American "Mustang." FIG. 3. Allison engines ready for testing after complete overhaul at an American equipment assembly and repair depot in England. FIG. 4. The British are eagerly awaiting the Martin B-26

Fig. 4. O.E.M. Defense Photo

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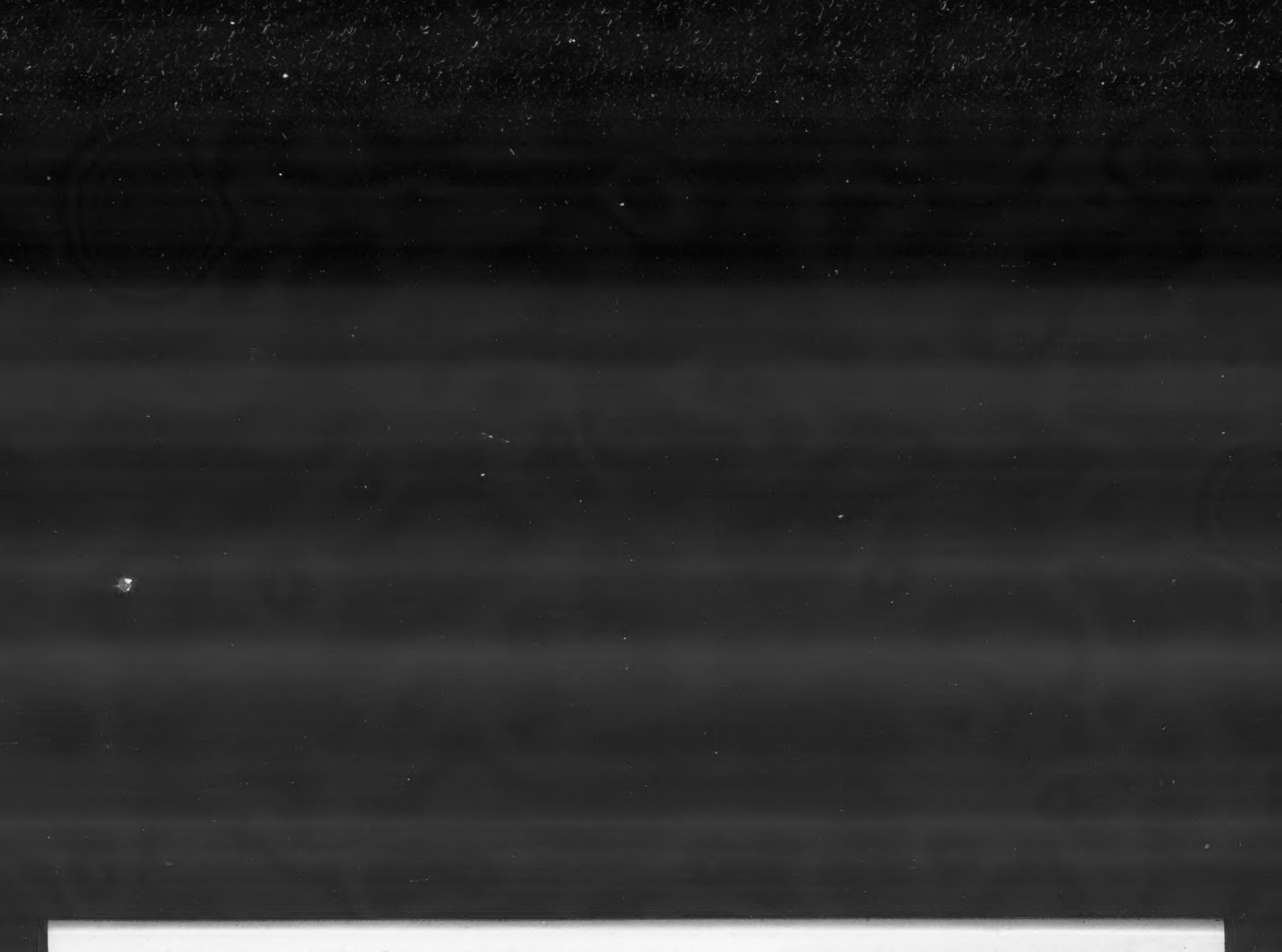

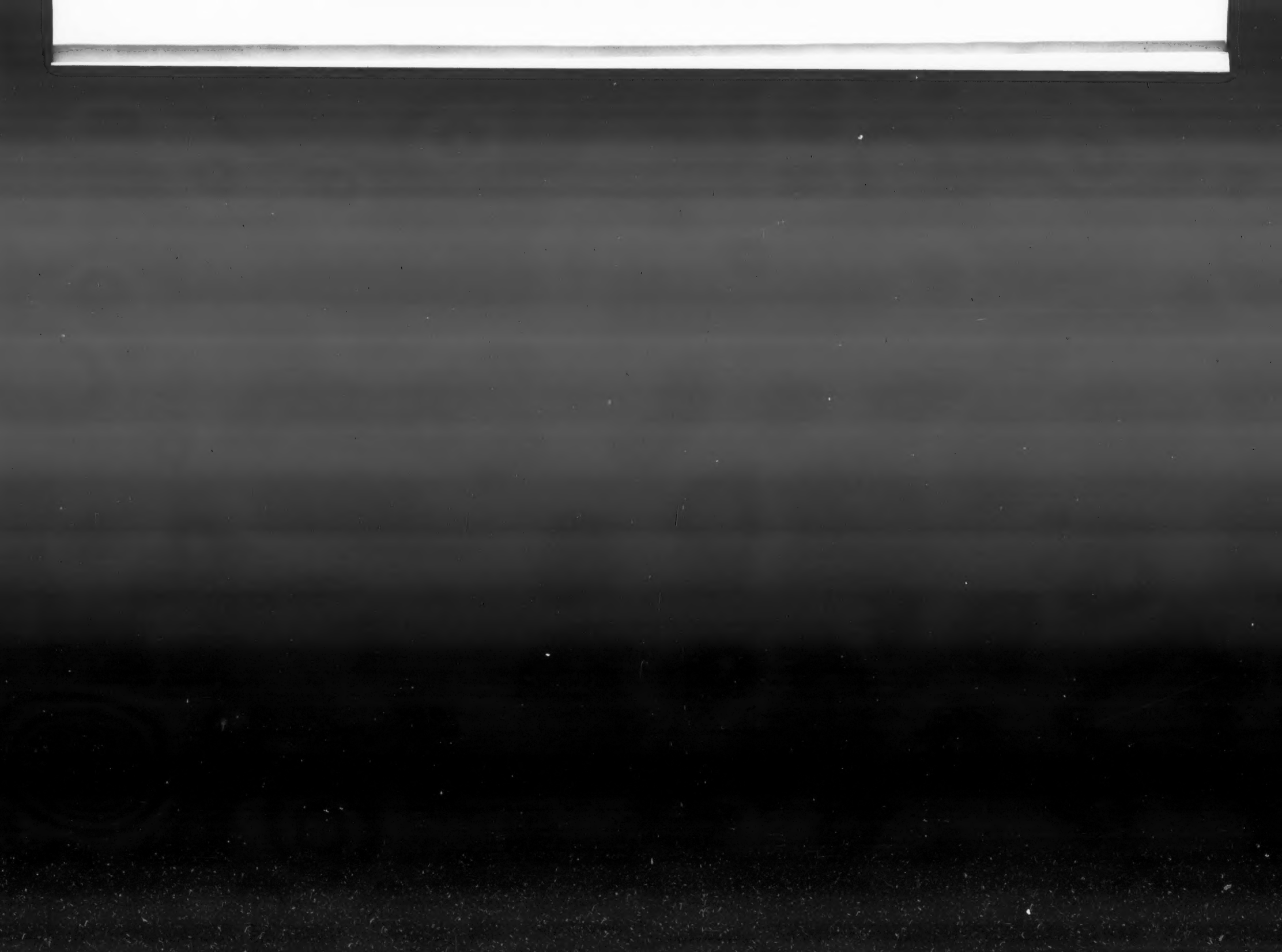

MANUFACTURING

Section of AVIATION

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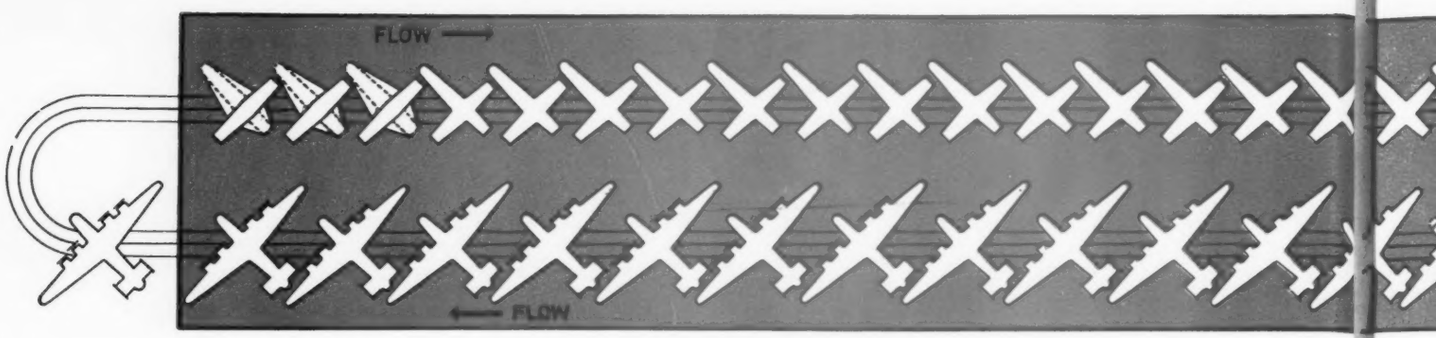


B-24's in Quantity Production

The B-24 is one of the 4-engine "heavies" which are revising the military textbooks. Called the Liberator by the British, these long-range, hard-hitting bombers are in action in all parts of the world. Here is described Consolidated Aircraft's mobile assembly line which sends them to the Allied Nations' Air Forces in ever increasing numbers.

By J. M. GWINN, Jr.
Supervisor Tooling and Methods, Consolidated Aircraft Corp.

HEAVY BOMBERS LOOM LARGE in our planning for victory. One of the most famous fighting ships in this class and one that has already won laurels in actual combat is the Consolidated B-24, called the *Liberator* by the British.

The B-24 has seen action both in Europe and in the Pacific war area. Gen. H. H. Arnold, Chief of the Army Air Forces, credits this type of bomber with the destruction of a number of German submarines. This ship holds the Ferry Command record between Newfoundland and England—2200 mi. in 400 min., an average of 330 mph.

The B-24 is built on a continuous final assembly line. Line assembly is used on most military airplanes that have reached the point of quantity production. But B-24 assembly is more than a line; it is a philosophy of manufacture and its keynote is mobility. Every element that has to do with the process moves with the planes themselves.

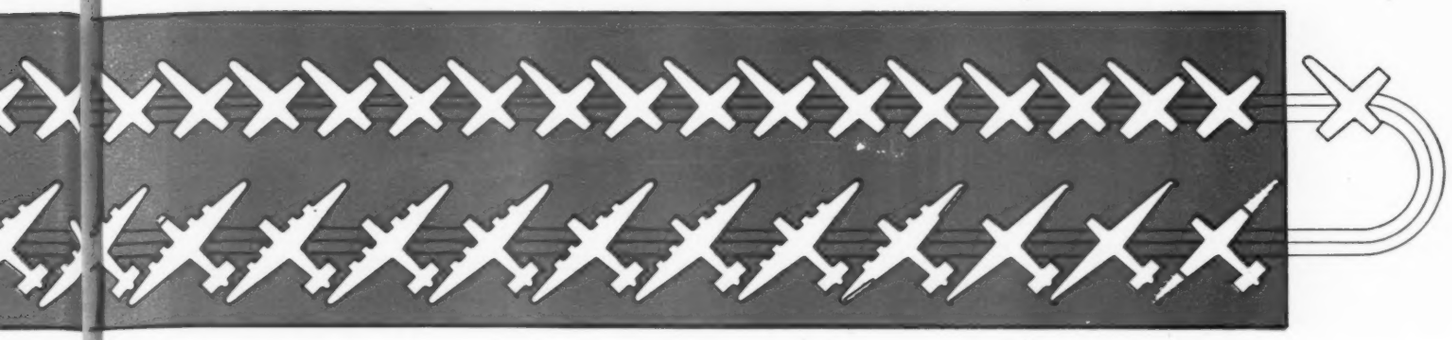
The building housing the line is merely a shell designed to shelter the operation. True it has compressed air and electrical outlets, tracks for the carriages to roll along, overhead traveling cranes, racks for parts and templates, and electric motors at the end of each section of the line to move the assembly from station to station. The point is that nothing in the way of essential tooling is fixed to the floor. Given another building of appropriate size and a few essential services, the line could be transferred overnight to a new location.

Some advantages of this philosphy are clear:

1. Flexibility is provided for changes

FIG. 1. History is being made in the skies, and the B-24 is helping to make it. This giant four-motor bomber is extremely fast for its size.

FIG. 2. Four of these 14-cylinder engines account for the speed of the B-24. This plane has high wing construction, tricycle landing gear and armor protection.



Consolidated's line for the B-24 bomber moves the assembly along at a 45-deg. angle to make fullest use of the plant floor area.

in design or in methods of production.

2. Tooling is mobile. It may be removed, placed in storage or taken from storage and put into operation. No jig foundations are needed.

3. Damage to the plant from military or other causes would create a minimum disruption to production. Whatever anyone thinks as to the likelihood of such damage, common prudence demands that it be guarded against.

4. Schedules can be varied without disturbing the general arrangement. Jigs are arranged in tandem instead of in company front. Hence more jigs can be added to step up output without altering the physical set-up of the line.

The line is oval-shaped; it progresses up one side of the building and doubles back on itself to go down the other.

To obtain space economy, the planes travel along the line at a 45-deg. angle. This arrangement nests them together nicely. The finished plane has a wing span of over 100 ft., but the 45-deg. angle enables it to be moved down the shop in a 74-ft. bay and back again in a 98-ft. bay besides providing an aisle and storage space. If the planes were carried along abreast, the increased floor space required would have cost at least $360,000.

The electric motors for moving each section of the line are hooked up so the line may be moved either continuously or intermittently. The line is moved intermittently at present. The motors have suitable gear reductions to give the proper speed. For moving the line continuously, the 5-hp. motor used for intermittent motion on each section is backed up by a ¾-hp. motor with an additional gear reduction to give a comparatively low speed. This second motor operates through the armature shaft and gear reduction of the first, but is connected to it by means of an over-running clutch so that it is inoperative when intermittent movement is used.

Stations one to three, inclusive, unite the three major subassemblies; the wing section, the fuselage nose section and the fuselage tail section. These subassemblies are brought from the Parts Plant by truck on a specially constructed trailer, adjustable to handle any one of the three. The wing section is carried in a cradle consisting of front and rear concave supports, padded to prevent damage in transit.

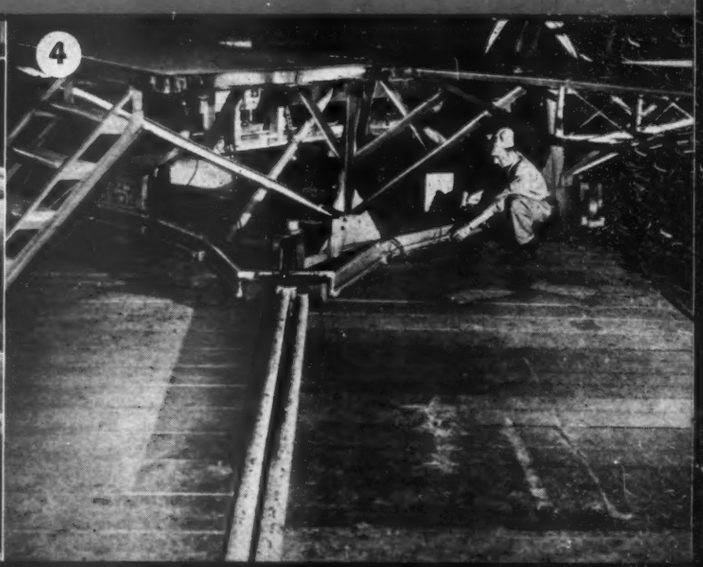
The fuselage sections are carried on three-wheeled dollies, cross-braced with tie rods previously used for their subassembly. The wheel arrangement provides three point support which avoids any changes in deflection due to the pull of gravity. In fact, the three-point principle is being incorporated into virtually all the new jigs built by Consolidated. It makes the jig self-supporting and mobile independent of floor plates or other means of support.

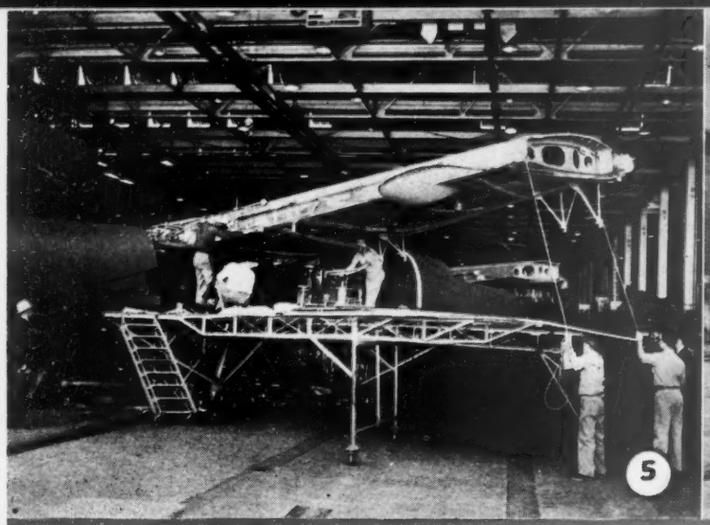
When used for transporting the fuselage sections, the rear cradle support of the special trailer is swung downward to the roadway on hinges by the removal of two pins. With the trailer in this position, the dolly can be run up on three tracks to bring its rear wheels directly over the trailer axle. The cradle support is then swung clear of the roadway for transportation to the final assembly line.

Other subassemblies, such as outer wing panels, ailerons and rudders, are

FIG. 3. Assembly of the B-24 is distinguished by the 45-deg. positioning of the bombers on the line and the mobility of the entire operation.

FIG. 4. The assembly carriage moves along three tracks on four pairs of wheels. Note the conveniently placed electrical outlets on the base of the carriage.





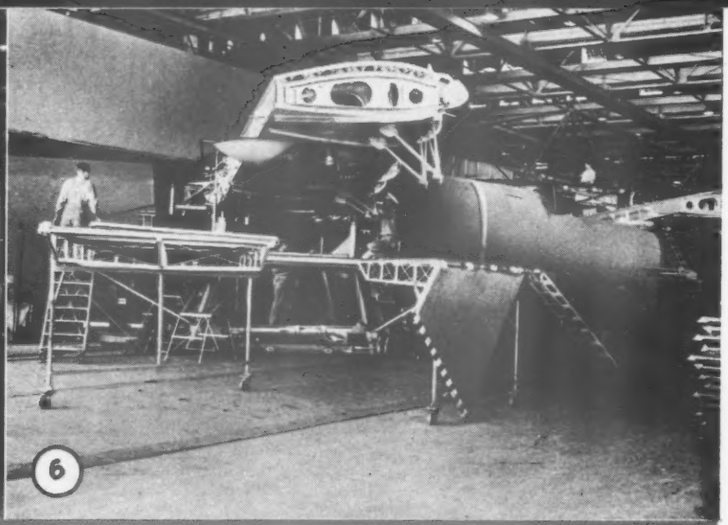
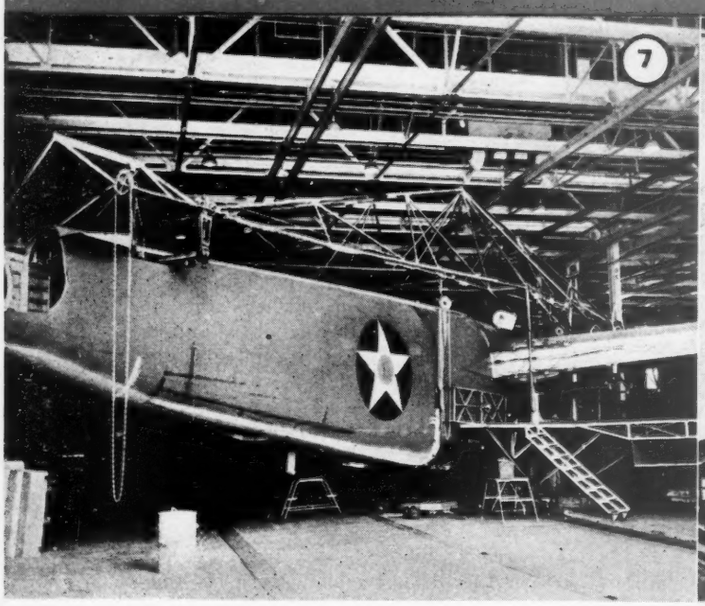
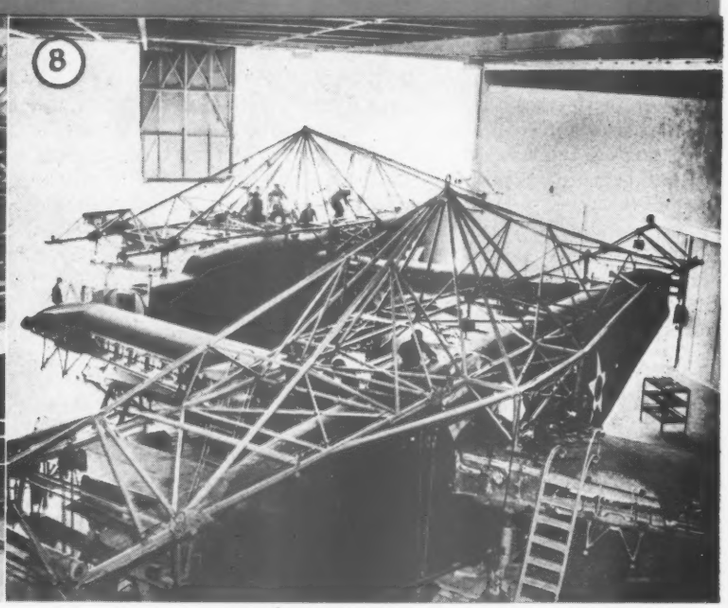


FIG. 5. The wing section is lowered into place on the carriage; care is taken to locate the vertical set pins in sleeves on the carriage posts. FIG. 6. The wing section now rests on the carriage, but the nose and tail fuselage sections are still held on their independent three-wheel dollies. The end flaps of the auxiliary platforms are kept down for the first half of the line. FIG. 7. A lifting and pushing fixture, carried on the mating jig, moves the tail section into mating positions. The nose section is handled in much the same way. FIG. 8. A craneman's view of the mating jig shows the strength of the tubular structure.





transported by truck using suitable wooden racks where required. Units furnished by outside vendors, including engines and propellers, are shipped in by rail or by truck. They can be unloaded directly opposite the station at which they are needed on the line.

Two crane runways run the entire length of the plant, one over each bay. Each runway supports two traveling cranes used for hoisting large subassemblies into place.

The carriage which takes the B-24 through its entire circuit of the line is built up of structural shapes and heavy tubing welded together. It consists of a framework having four vertical posts and eight wheels, one pair under each post. The square thus formed travels along one of its diagonals on three tracks. The diagonally opposite two pairs of wheels that follow each other along the center track are pivoted and flanged. These guide the carriage. The two outer pairs of wheels are fixed and have no flanges.

All the carriages in each section of the line are linked together with tie bars which fix their spacing and move them along when the carriage at the head of the line is pulled forward. For the first section of the line, the carriages are spaced on 46-ft. centers, but for the return section this dimension is increased to 65 ft.

The tie rod is of hinged design to take care of the change in center distance. Only a single solid length is used along the first part of the line. The tie rod is disconnected as the carriage leaves this section to be swung around on a semi-circular length of track for its return trip. When the tie rod is reconnected, it is swung on its hinged joint to its full length. A similar semi-circular length of track at the end of the final half of the line makes it possible to swing the carriage into the starting station without additional handling.

Subassemblies come to the final assembly line with as much work as possible already completed. Each structure is an integral unit itself, and all wiring, piping, sheaves, and connections are in place. All parts and subassemblies are given their last coat of paint before reaching the line. Retouching is done during lunch hour with a spray gun if necessary.

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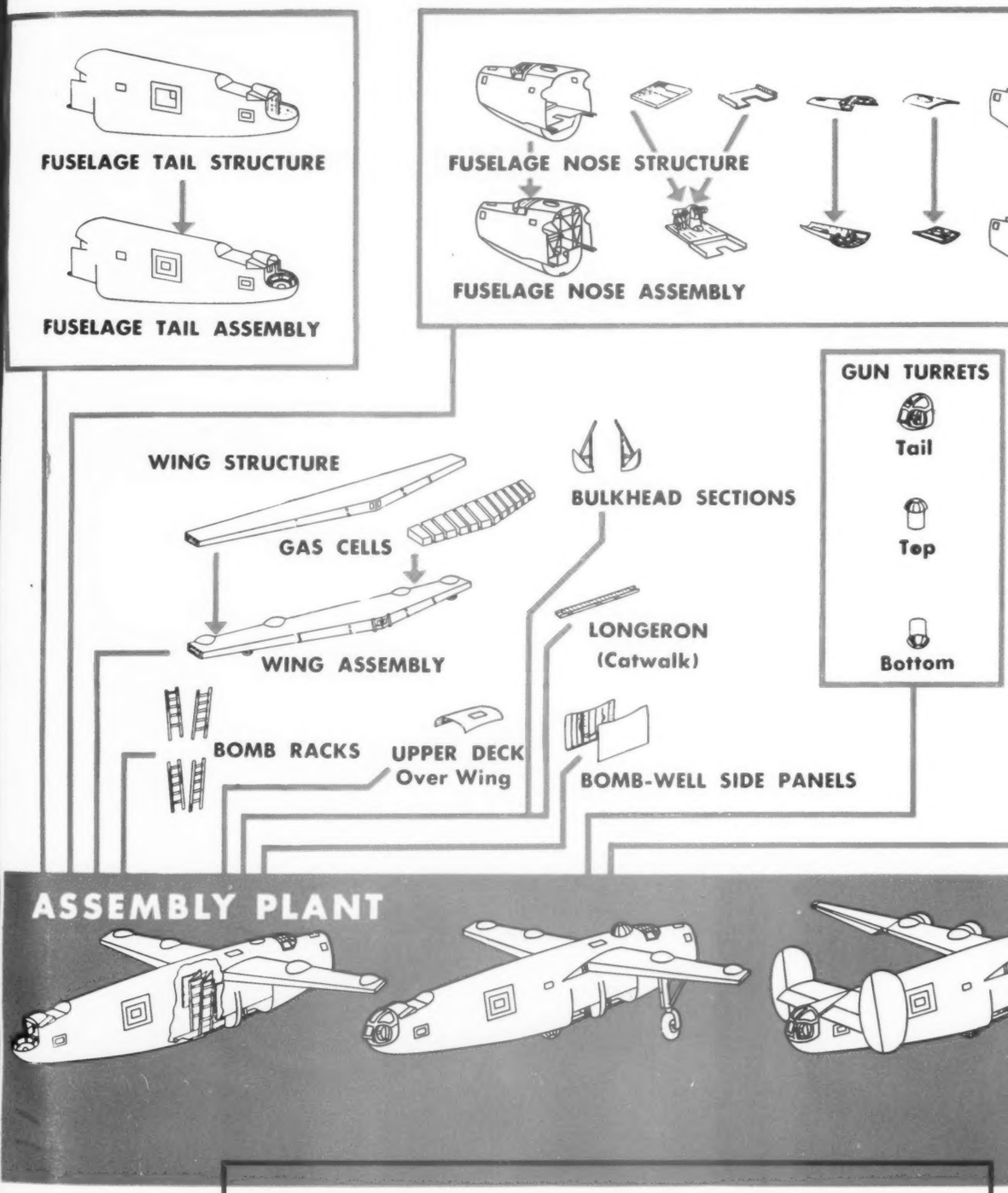
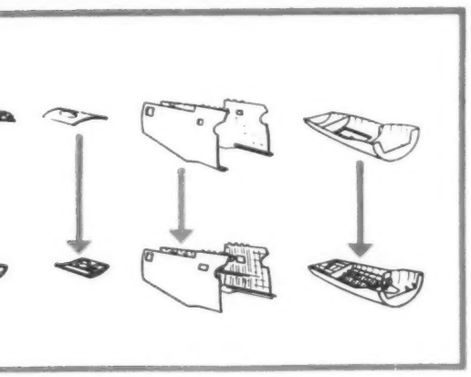
ASSEMBLY PLAN OF THE CONSOLIDATED B-24



Parts and subassemblies flow into the main line as indicated. Not shown are hundreds of component parts that go to make up the complicated structure of the modern bomber.

B-24 . . .

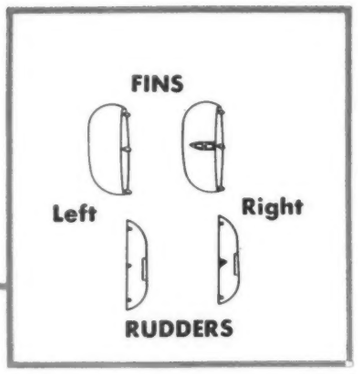


UN TURRETS

Tail

Top

Bottom



STABILIZER

ELEVATORS

LEADING EDGE SECTIONS FOR WINGS

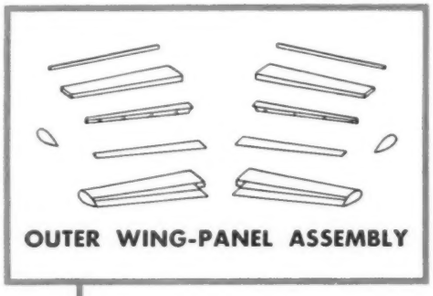
NOSE ENCLOSURE

CENTER WING REAR SECTION

FOWLER FLAPS

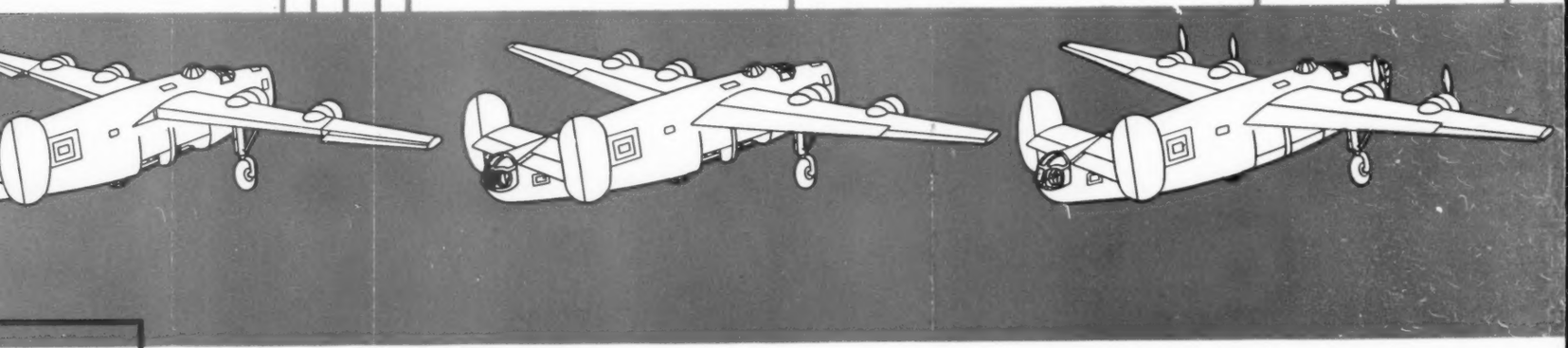
ENGINES

LANDING GEAR
Tricycle



BOMB-WELL DOORS

PROPELLERS



shown are
d structure

WING CENTER SECTION

1. Wing set pins are installed on either side of the rear spar of the wing center section.

2. The wing center section is lifted, using a lifting bar, in traveling crane. The angle of incidence of the suspended wing is adjusted by turning a crank at the forward end of the lifting bar.

3. The wing set pins on the rear spar of the wings are guided into sleeves on the aft legs of the assembly line carriage.

4. Capscrews on the forward leveling pads are set up to contact the spar flange, thus preventing slippage. All four leveling pads on the carriage are pivoted and can be adjusted vertically.

MATING JIG

5. The lifting bar is removed and the overhead mating jig is lowered to the top of the wing section. Sleeves attached to the jig are guided over the top ends of the wing set pins.

6. Leveling pads on the overhead mating jig are clamped to the wing spar flanges.

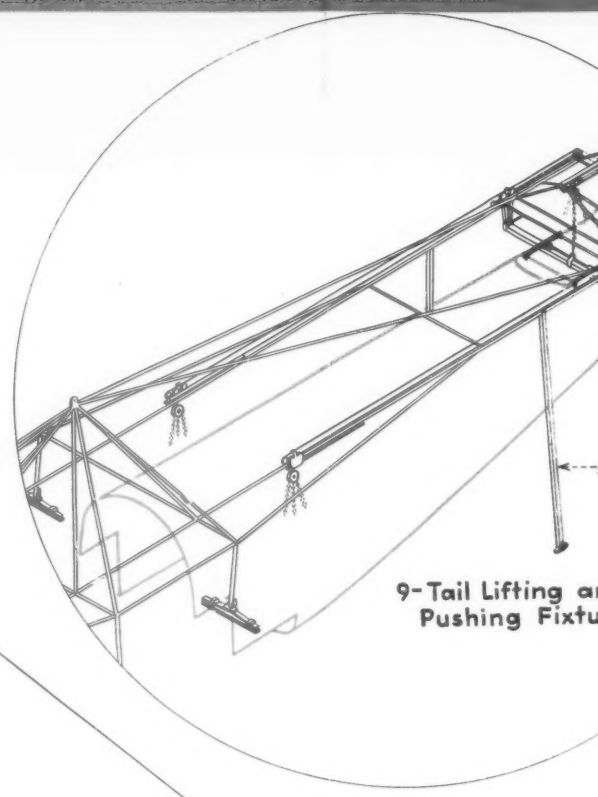
FUSELAGE NOSE SECTION

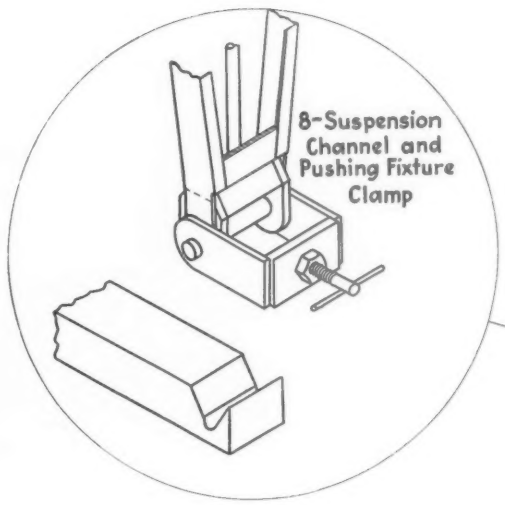
7. The front nose attachment fixture is connected to the nose section bulkhead. The nose section is rolled into position under the forward end of the mating jig on its own dolly. Using the hoist of the lifting fixture on the mating jig, the fixture yoke is lowered and bolted to the nose attachment fixture. The lift strap for the aft end of the nose section is hooked to the hoist chains on the pushing fixture. The dolly hold-down straps are released. With wooden props under the mating jig, the three hoists are operated simultaneously to lift the nose section.

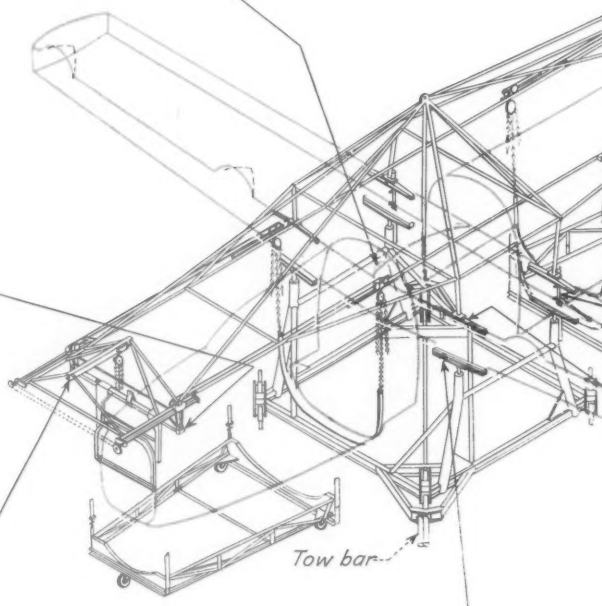
8. The nose mating fixture is received into and clamped to the pushing fixture. A chain fall operates the pushing fixture to move the nose section aft into mating position.

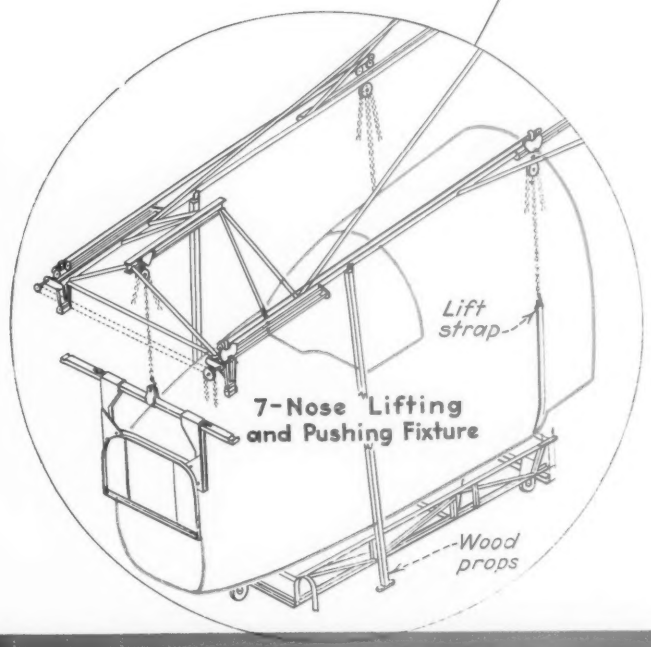
FUSELAGE TAIL SECTION

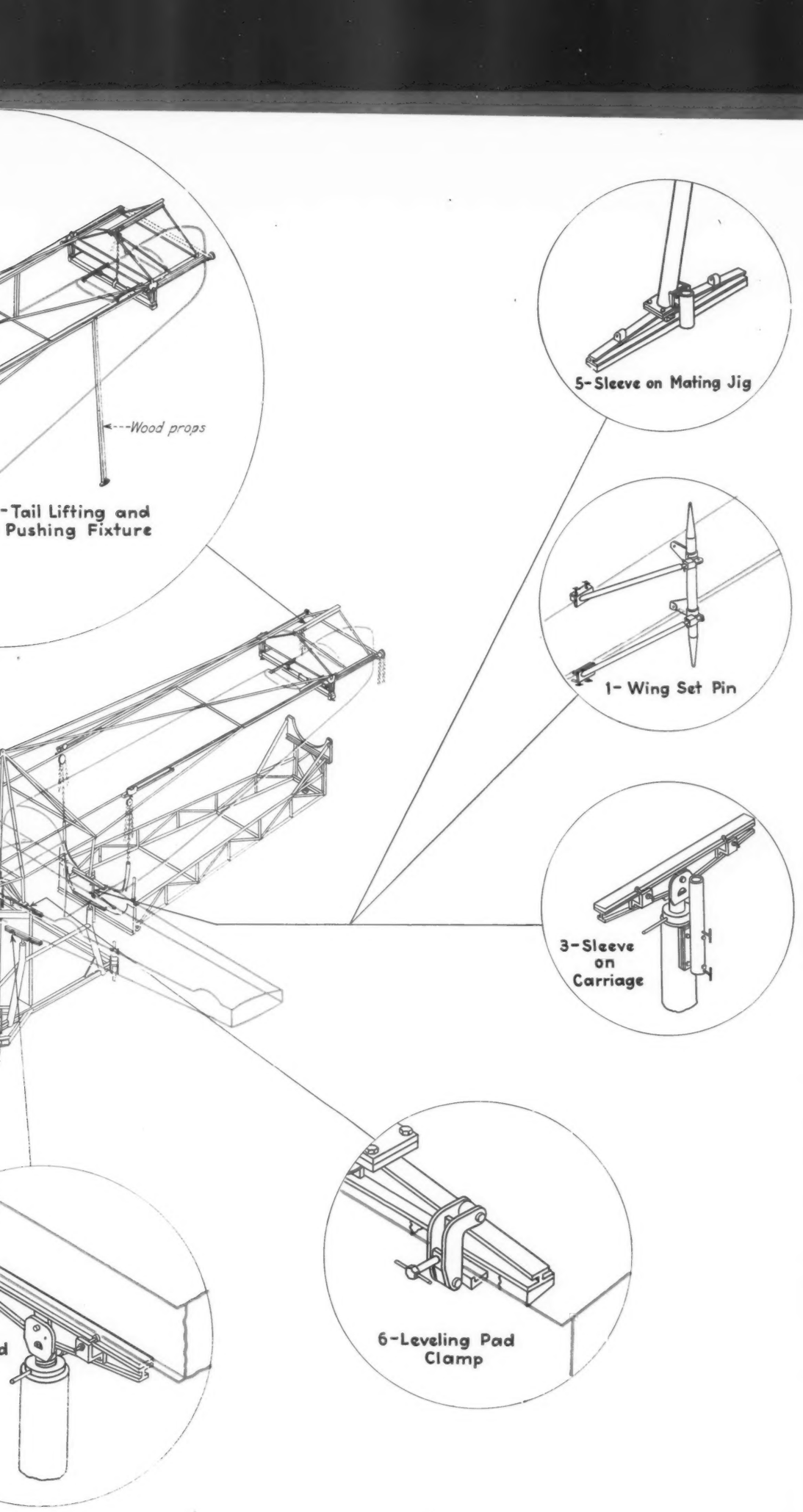
9. The tail section is rolled on its own dolly under the aft end of the overhead mating jig. Using the hoist of the lifting fixture, the tail mating fixture is lowered and attached to the tail section. The lift strap for the forward end of the tail section is hooked to the hoist chains on the pushing fixture. The dolly hold-down straps are released. With wooden props under the mating jig, the three chain hoists are operated simultaneously to lift the tail section. The suspension channel of the tail mating fixture is received into two clamps on the pushing fixture. The tail section is moved forward to the mating position by the operation of the pulley chain of the pushing fixture.

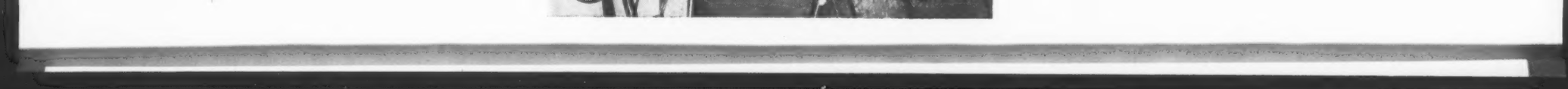









Wood props
-Tail Lifting and
Pushing Fixture
5-Sleeve on Mating Jig
1- Wing Set Pin
3-Sleeve
on
Carriage
6-Leveling Pad
Clamp



The first step in asembly is to mount the wing section on the carriage. It is picked up from the trailer by a sling in the traveling crane deposited in the four supporting posts. The wing section is squared in position by means of Z angle guides with adjustable buttons on all four posts. All posts are adjustable vertically by means of elevating screws used to level the wing section.

The mating jig is lifted in the traveling crane and placed over the wing section. This jig, as its name indicated, locates the wing and fuselage sections in their correct relative positions. Three such jigs are now used and carry through the first three assembly stations. At the third station, the jig is released and carried back by crane to the start of the line to be used over again. The jigs are of welded tubular construction and are rigid enough to be independent of deflection caused by gravity.

With the wing section in place, the nose and tail fuselage sections are wheeled in on their dollies. At each end of the mating jig there are three chain hoists for elevating the fuselage sections into place. A positioning plate topped by a horizontal beam is bolted to locating holes in the bomber's window mounting bulkhead of the nose section. The forward chain hoist hitches to this beam while a belly band is fastened between the other two hoists on the nose of the jig.

All hoists are movable along trolleys in the jig. That at the forward end is actuated by a pulley through lead screws so that when the nose section is elevated it can be moved back into the wing section. The two other hoists are connected by cables and sheaves to maintain their relative positions on the trolleys, thus keeping the nose section square with the wings.

The same procedure is used to hoist the tail section of the fuselage. Here the position of the pulleys is reversed with the single pulley at the rear carrying a straight beam passed through plates attached to the empennage connecting holes. Hoisting and longitudinal movement are carried on as for the nose section. For additional stability, nose and tail fuselage sections are held to the carriage with canvas straps.

The three major subasemblies, positioned on the center line of the fuselage in the mating jig, are then riveted together. Outlet boxes for electricity are sunk in the floor along the entire length of the asembly line. Compresed air lines parallel the two outer tracks with connections spaced at short intervals. The mating jig is wired and piped so that a single connection to each service provides adequate outlets for all working positions. There are three junction boxes, each with four outlets and three air valves on each of the four sides of the jig. The riveting tools can thus be connected conveniently.

The carriage is similarly wired but carries no air lines since the bulk of the rivets are driven at the first three stations. However, the floor air outlets may be used directly at any station. In moving the carriages from one station to the next, the air and electric lines are disconnected, and wire and hose is cleared from the tracks.

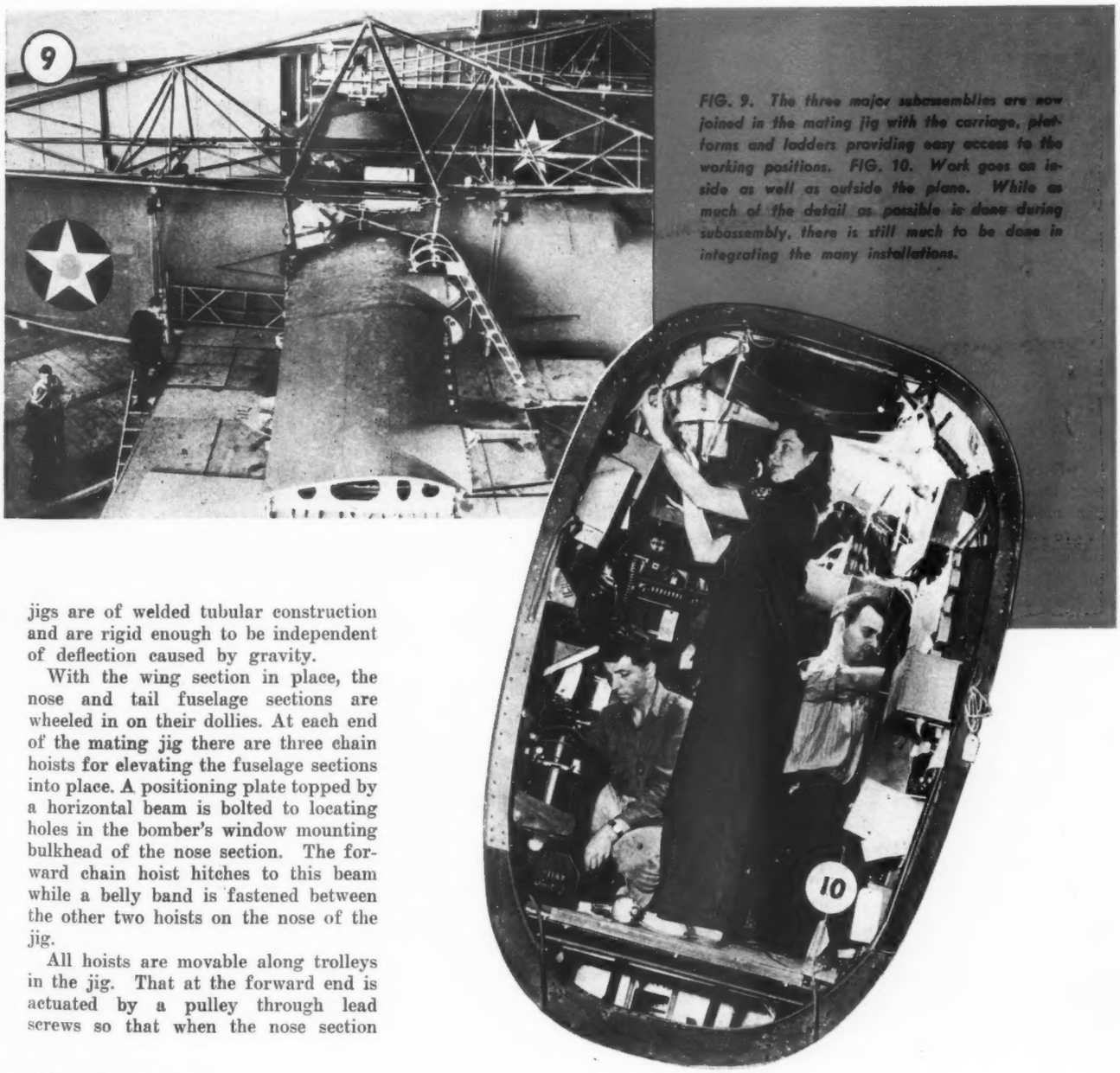


FIG. 9. The three major subassemblies are now joined in the mating jig with the carriage, platforms and ladders providing easy access to the working positions. FIG. 10. Work goes on inside as well as outside the plane. While as much of the detail as possible is done during subassembly, there is still much to be done in integrating the many installations.

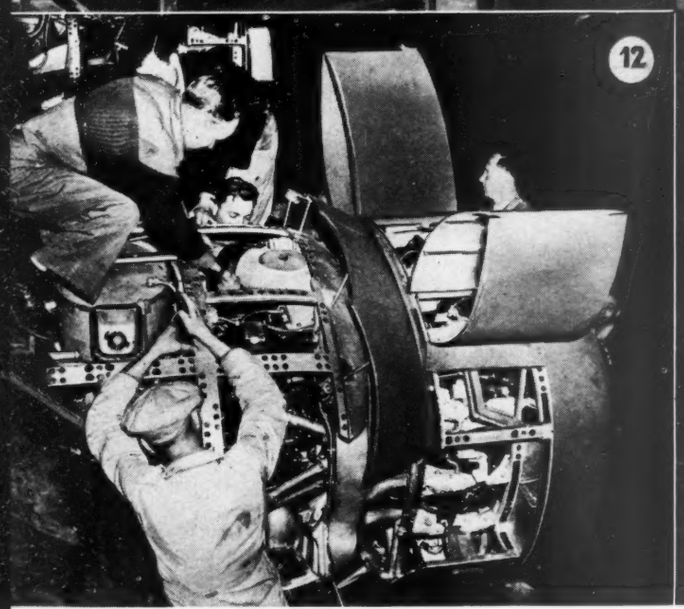


FIG. 11. Parts are recorded when assembled to the bomber by colored counters hung on control boards at the end of the stock racks. FIG. 12. After the engine is hoisted into place on the second half of the line, it is bolted to the wing section and connected to the bomber controls. FIG. 13. Cowling, previously fitted to the engines, is carried along with the assembly under the carriage until ready for installation.

The carriages have upper and lower work platforms upon which wooden flooring is laid. After the wing section is mounted, four auxiliary platforms are hooked to the carriage. These extend outward parallel to and on either side of each wing. Each auxiliary platform has two wheels in line with the direction of travel. A connecting walk between each pair of platforms leaves an inclosed well under each wing so that the landing gear can be installed and operated on the line. The two platforms at the outer corners of the square have hinged flaps which hang down for the first section of the line to give adequate aisle space in the narrower bay.

For the return section of the line, these flaps are swung upward to provide additional working areas, and two more auxiliary platforms are hooked on ahead of the wings to provide the space needed in working on the nacelles.

All platforms are made accessible from the floor by means of light step-ladders which hook onto them. The ladders also have wheels so they can be moved along with the carriage.

Portable stands enable the assemblers to reach high points on the plane. These are moved to any convenient location on top of the platforms. Ladders are also used on the platforms so the workers can readily climb to the tops of the wings. At one or two stations, special high floor stands are required to reach the front end of the nose section.

The general plan of assembly is to use the first half of this line to complete all operations on the wing section and fuselage. This work involves a vast amount of detailed fitting needed to coordinate the three subassemblies and to add many small parts that could not be installed in the parts plant. On the second half of the line, major units are added to complete the plane. The additional space required by these units accounts for the greater center to center spacing needed on this part of the line.

While the assembly is still in the mating jig a radius rod is installed on either side between the nose section of the fuselage and the jig posts. These rods keep the assembly square with the jig all along the line. The Z angle guides used initially for squaring the wing section must be removed further along the line when the wing leading edges are installed. Were it not for the radius rod there would be nothing to prevent the assembly from pivoting on the fixture after the guides are removed.

During the mating operation, bomb-well side panels, bomb racks, upper decks over the wings, cat-walk and bulkhead segments are all added.

After the mating jig has been removed, the assembly moves down the first half of the line. The parts needed for the installations in these stations are located on racks along the line in convenient locations.

A simple and convenient method is used to keep a record of parts on hand and to forestall shortages. All the parts needed at a given station are listed on a board hung on the side of the stand. Opposite each part is a hook which carries a series of metal

disks with holes in them like Chinese money. The disks are of two colors: red and black. Each represents a part on hand ready for assembly.

The red disks represent the minimum supply, which is the quantity required to last until a new lot of this part can be processed. The black disks indicate quantities in excess of the minimum.

As parts are used, the stock leadman at each station removes the proper number of disks from each hook. When he gets down to the red disks on any part he is warned that he is dipping into his minimum quantity.

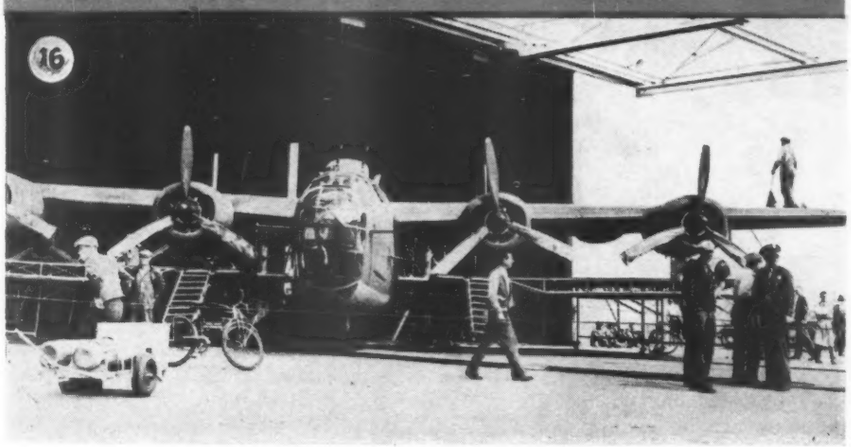
At the right-hand side of each part are three columns: date below minimum, date listed and date of next supply. As soon as the leadman uses a part that calls for a red disk, he notes it in the first column. The stock chaser inspects these boards daily and records his listing of the parts in the second column. When he determines the status of the next lot of parts in process, he puts its completion date in the third column.

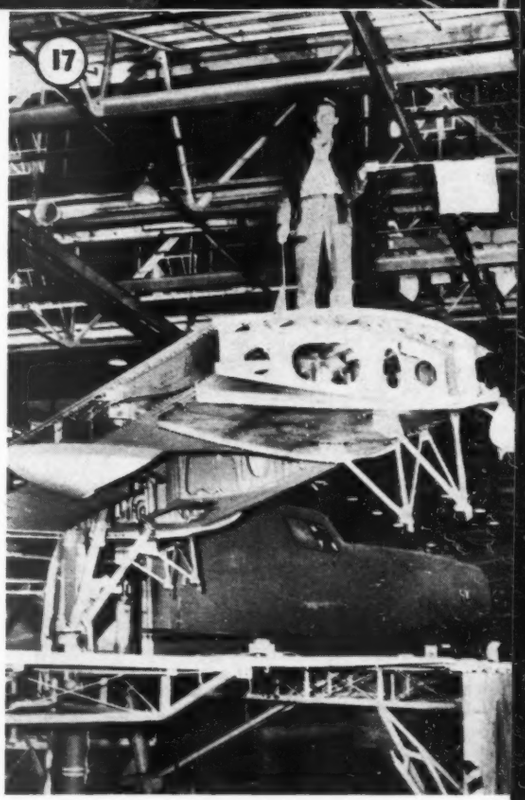
Despite all precautions, shortages will occur. An advantage of this mobile method of assembly is its flexibility, and usually no delay is experienced in adding such parts at a later station. This practice is not desirable, however, as it interferes with precise timing on which the performance of the line is predicated.

Every effort is made to predrill all parts by the use of jigs so that rivet hole drilling during asembly will be kept to a minimum. Predrilling is now done successfully on bomb-well side

(*Turn to page* 323)

FIG. 14. Even after the nose inclosure is fitted to the bombardier's compartment, radio and other installations have to be completed. FIG. 15. To make the B-24 assembly 100 percent mobile, the leadman's desk is mounted directly on the carriage and moves along with it. FIG. 16. The bomber unloads itself from the carriage when compressed air is applied to the oleo struts. FIG. 17. "All Clear" signals the flagman. The line of bombers marches ahead to add another major unit to our rapidly growing air force.





"War Production of Aircraft"

Subject of Joint Meeting of the Detroit Section, Society of Automotive Engineers and the Engineering Society of Detroit.

Theodore P. Wright, assistant chief aircraft branch, WPB (left) and Col. Arthur W. Herrington, SAE president just returned from a war mission to India, were two of the principal speakers at the Detroit meeting.

THAT DETROIT is decidedly aircraft conscious was evidenced by the enthusiastic attendance at the SAE meeting June 8, of men who in the past have only been associated, with the automobile industry. The meeting took the place of the usual summer meeting of the SAE, was a one day affair and had one of the most interesting exhibits that has ever been shown at any SAE meeting.

The exhibit was furnished by the Ford Motor Company, and not only showed the development of the airplane engine from the third Wright Brothers' four-cylinder model to the latest supercharged Pratt & Whitney type built by Ford but indicated, with many other exhibits, how the auto industry has been converted to aircraft production.

Engineering papers were presented during the day followed by an evening address given by Theodore P. Wright, assistant chief aircraft branch, WPB. Arthur Nutt, past president SAE and chief engineer of Wright Aeronautical Corp., presided. Col. Arthur W. Herrington, president of SAE, was a surprise speaker, having just returned from his mission to India. The short talk which he gave was one of the high spots of the entire meeting.

Seen inspecting the exhibition prior to the evening meeting were Henry Ford, Edsel B. Ford and his son Benson Ford, Chas. E. Sorensen of the Ford Motor Company, Fred Zeder of the Chrysler Corporation, O. E. Hunt and Chas. F. Kettering of General Motors, Bill Stout and practically every chief engineer or production executive of the entire automotive industry. John A. C. Warner, general manager SAE and C. B. Wittelsey Jr., of the New York office, were in evidence throughout the day. Aircraft terms were handled as glibly, at this meeting, by automotive men as though they had always been in the aircraft business.

The setting of the meeting was in the recently completed temple of engineering, the Rackham Memorial which graces the Detroit Art Center, and houses not only the Engineering Society of Detroit but provides one of the finest auditoriums in the city for holding such meetings as this. It also houses the Extension Division of the University of Michigan.

"United States fated to lead the world", was the gist of Col. Arthur W. Herrington's short but forceful message that struck a responsive chord in 2,000 or more engineers who packed the auditorium to overflowing.

"Our nation is approaching its destiny," he said. "We are fated to be the leaders of the new world. . . There can be no peace hereafter unless we now recognize that the principle of empire and economic exploitation of the rights of peoples must be brought to an end.

"The most hopeful thing which I find upon arrival in this country, is that the President of the United States and his immediate advisers are fully abreast of the situation before us and that they have no illusions concerning it.

"Until you have flown 38,000 miles outside of the U.S.A. in two months you cannot appreciate this country. The most alarming thing I heard on my return to this country was the optimism which everyone seems to have about the war. This confidence of ignorance has brought too many countries to their knees. We have not come close to winning this war. We cannot possibly finish this war this year," he added.

Col. Herrington, an Ordnance engineer, experienced tank builder and veteran of the last World War, has just returned as one member of the five man mission to India, headed by former Assistant War Secretary Louis A. Johnson. Herrington referred all his listeners, who want to know the facts to an article, What Are We Fighting For?, written by Mme. Chiang Kai-shek, and published in the *New York Times*, April 19, to Vice-President Henry Wallace's speech on May 8, and to the Memorial Day speech of Undersecretary of State Sumner Welles.

Harvey Merker, president of the ESD and E. W. Austin, President of the Detroit Section SAE both welcomed the guests. Thanks were extended to Carl F. Bachle, of Continental Motors Corp., and Peter Altman of Vultee Aircraft, Inc. who as respective SAC vice-presidents of Aircraft Engine and Aircraft Engineering were responsible for the papers and arrangements.

With 25 years experience in aircraft building and his present position Theodore P. Wright was well qualified to cover the comprehensive subject *Our War Production Effort in Aircraft.* Confidence is one of the first requirements in the successful prosecution of a war . . . We must have confidence in our cause, our state, our leadership, our army and navy, and our equipment he explained. . . Our equipment is second to none and superior to most. . . . We have benefitted from the experience of the English with their two years of front line work. . . Our production is ahead of schedule. . . We have only started our production, it will be threefold in 1943. These things should conjure doubt and fear in Hitler for the doom that is waiting for him", were some of the other points he mentioned.

"Production", he continued, "depends upon materiel, management, machines, material and men."

"Changes have to be rapid in military aircraft for three reasons," he said, Modernization, Standardization and Refinements. The first is due to lessons learned at the front, the second, to eliminate dual production lines and the last, to delight engineers and give production men headaches."

He complimented the automotive industry indirectly when he said, "It took them longer to get started than we expected but once in production it has been going faster than we expected."

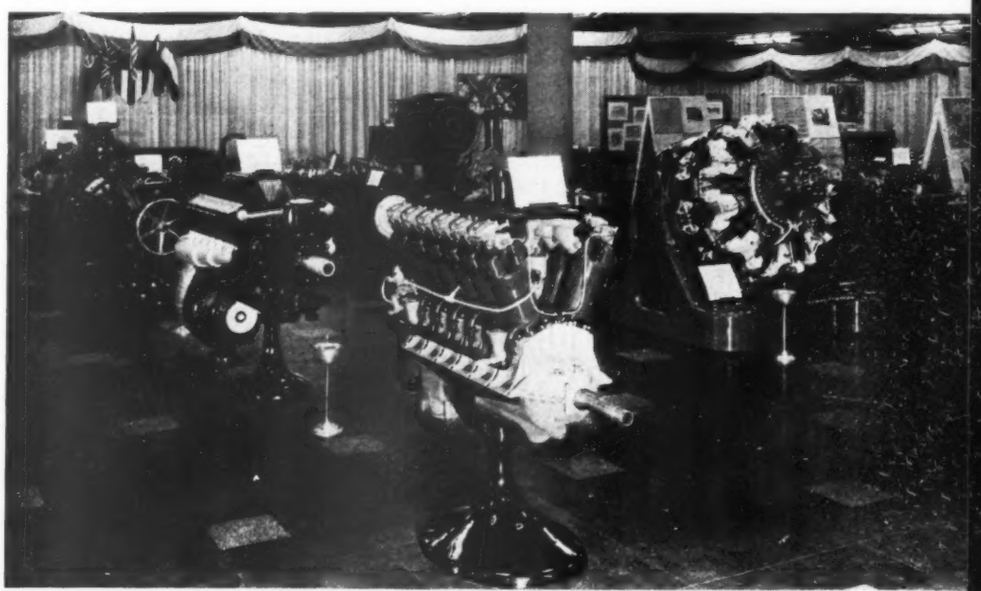
Machine tools were vitally important in getting started. According to his figures there was a 100 percent increase in machine tool deliveries in 1941 over the previous year and 1942 will step this up 25 percent more. In 1941 we did not have tools enough. We are just now beginning to have material supply troubles and they will get worse as production steps up. In 1941 there was no shortage of labor but it is getting bad in 1942. Women may be the answer. Only one percent of the employees in the aircraft industry were women in 1941. In 1942 they will average about 10 percent in aircraft building and 5 percent in engine building. By 1943 the percentage should be 40 and 25.

Fifty-hour weeks are the average of the industry right now. Two shifts are used where labor is scarce and three where it is more plentiful.

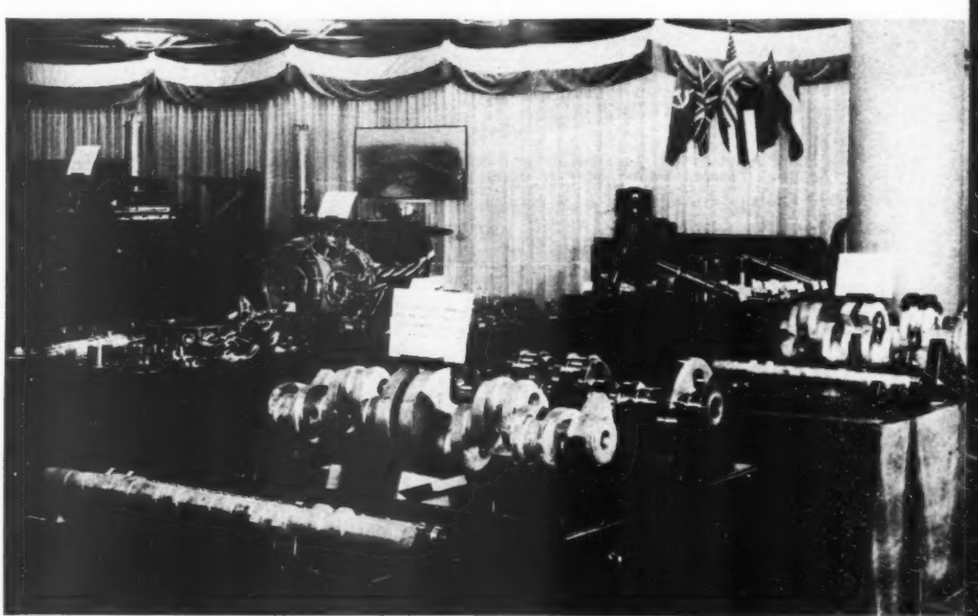
Wright pointed out one great truth that should be quoted, "Democratic government is inefficient because it is based on a system of checks and balances. All agencies have veto power but few have power to get something done."

He also emphasized the need of service and spare parts in the field. Those things which are determined by war experience. "A reconditioned aircraft at the front is worth thousands that are 8,000 miles away," he said.

"Few people have understood what conversion has meant to the automotive industry. Of the old equipment available, 35 percent was the highest available and probably 15 percent was the average for the entire industry. Even many of the buildings were unsuitable. The real contribution that came from the conversion was the automotive management. . . Today 80 percent of the auto industry is on war work. . . The industry has had to learn that with twice the labor needed to turn out 1,500 cars a day they can only get 15 airplanes. . . The technical rivalry and experience with the different methods used by the



Aircraft parts, latest aircraft and tank engines and historic aviation powerplants were shown side-by-side at the Detroit meeting of the Society of Automotive Engineers and the Engineering Society of Detroit. In the foreground is the famous Liberty engine of 1917. Behind it is the Ford experimental liquid-cooled in-line engine, the new Ford 8-cylinder tank engine and a captured German Daimler-Benz aircraft engine. On the right is the 2,000 hp. Pratt & Whitney engine being manufactured under license by Ford.



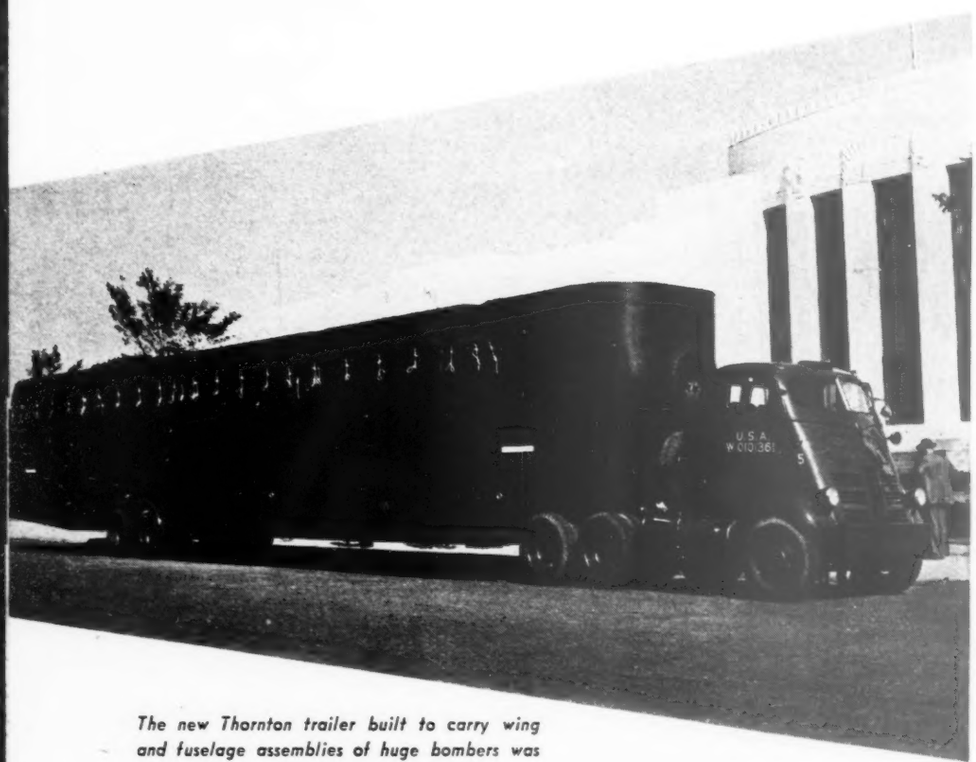
In the foreground are rough and finish steel crankshaft and camshaft castings for the Ford experimental liquid-cooled engine, and behind them are similar parts for the tank engine. In the background are parts of the dis-assembled Mitsubishi-Kinsei I engine, shot down by American forces.

two industries, however, will do all of us good. . . Subcontracting has moved ahead steadily since March 1941, when 15 percent of the work, on a dollar basis, was subcontracted. . . Today it has reached 36 percent."

In conclusion he said with pride that, "In 1941 the Axis was building two planes to our one. This year will find us building as many as they are. We will more than double that in 1943."

Altitude Performance of Oiling Systems

At the morning session, two papers were presented, both on the same subject but from different aspects. J. Dolza covered the theory and test methods used by Allison Division of General Motors Corporation while H. C. Karcher of the same organization told how the actual altitude flight pereformance compared with the theoretical and test chamber results. S. K. Hoffman, Aviation Corporation, Lycoming Division presided as chairman at the meeting.



The new Thornton trailer built to carry wing and fuselage assemblies of huge bombers was on display during the SAE-ESD meeting. Overall length of the tractor-trailer unit is 72 ft. Two of these units will carry a complete bomber except engines, a load normally requiring seven railroad freight cars.

The construction of the altitude test chamber was fully described by J. Dolza. This test chamber was particularly interesting because it not only provided means of testing the oiling system of an engine under low pressures that are comparable with high altitude flight conditions but it is completely mobile so that any altitude conditions can be simulated. In other words, the effect of climb and dive can be duplicated and furthermore slow barrel rolls can be tried while the system is under test. The system was developed to determine practically every flight condition that an Allison aireraft engine oiling system might experience.

The altitude chamber was built so as to eliminate the large errors in measurement of oil and coolant flow encountered when the system being tested was surrounded by room pressure and only the oil and coolant were subject to the low pressure simulating altitude operation.

The altitude test chamber is a steel drum, 6 ft. in diameter and 10 ft. long with a glass enclosure at one end so that all the gages, which are located inside the chamber, can be observed and photographed for permanent record purposes. Placing the gages inside the chamber made it possible to eliminate corrections and simplify the set-up of the test apparatus. The chamber is mounted on ball bearings on a frame so that the chamber can be rolled around its longitudinal axis. The frame which supports the ball bearings is mounted in trunnions. Thus the whole test chamber can be inclined in the vertical plane to simulate the attitude of climb and dive conditions.

To facilitate tests the set-ups are made outside of the altitude chamber and inserted in it. They not only carry the entire crankcase engine oiling system, oil tubing and pumps but also all the electric driving motors and all the gages that are needed for the test. The gages are all located at one end of the set-up so that they can all be observed through the glass end of the altitude chamber and photographed for record purposes.

One important feature of the test set-up is the use of a constant oil tank level. The purpose of this was to determine the effect of oil level in the tank upon pump capacity. It has been found that oil pump flow changes with variations of oil level in the airplane oil tank while it does not change appreciably with oil level in the crankcase if the mixture of the air and oil supplied to the scavenger pumps is equal to the stabilized flow.

What Test Chamber Taught

The author then reviewed some of the findings from altitude changes and gave the fundamental formulas for analyzing performance. Then the experimental corroboration of the theory was given. Internal and external tooth pumps were both discussed. The three most important causes of pump displacement loss were given as: internal leakage between the pressure and intake sides of the pump; incomplete filling of the space between the teeth and the most serious, aeration of the liquid being pumped.

The first problem is controlled by end play and radial clearance and is very important because it determines the priming time. This loss, due to leakage, may average six percent.

Incomplete filling of the tooth space occurs when the pressure at the intake side of the pump is not large enough to overcome the centrifugal force imparted to the liquid by the gears plus the acceleration force needed to fill the tooth space. This is influenced by the viscosity of the oil and the oil pressure drop due to restrictions in the oil lines, also pump internal pressure losses at the intake. The test were run to prove at what maximum altitude the pressure ceased to be sufficient to fill the tooth spaces. This problem brought out the difference in altitude at which slow speed and high speed oil pumps ceased to operate at full efficiency. A 4,500 rpm. pump reached its maximum at 11,000 ft. altitude while a 2,750 rpm. pump did not start to fall off until 18,000 ft. had been reached.

Restricted Oil Lines

Restrictions in the oil lines were equally important, if not more so, because they could be added by the airplane builder without the knowledge of

the engine builder. How important this is was shown by the figures showing the effect of increasing the oil tank supply line from 1 to 1½ in. With the smaller line 12,000 ft. was the best altitude obtainable while 18,000 was possible with the larger tubing. The internal pressure losses were 7 lb./sq.in. and 3 lb. respectively.

One of the most serious problems, according to Dolza, was aeration of the oil. This increases rapidly as the pressure in the oil tank is reduced by altitude, up to the pump critical altitude. There are several important ways to reduce it. How serious this aeration is may be gleaned from these facts given by the author. Inclusion of five percent air in the oil will cause a loss of twelve percent in oil pump capacity due to the expansion of the included air. It will bring the altitude limit down from 38,000 ft. to 24,000 ft., with a 1½-in. suction line, but this will fall to 11,300 ft. if the ship has a 1-in. oil pump feed line instead.

Prompt Pump Vital

Pump priming is important too, as in-line engines have two scavenger pumps, one for climb and flight the other for glide and dive. It is of vital importance that these pumps prime immediately after a change of flight attitude otherwise the oil pressure pump, after exhausting the oil supply in the tank, will be unable to supply oil to the bearings. After momentary interruption only rapid priming will restore oil to the engine bearings before failure occurs.

While priming the oil pump acts as an air compressor. A gear pump therefore has to compress air from approximately atmospheric pressure to the outlet pressure represented by the oil head between the scavenger pump and tank inlet. This is affected by the check valve sometimes used on oil coolers, also the viscosity of oil and its temperature.

The author claims that a scavenger or oil pressure pump with lubricated gears and close clearances will always prime at any altitude if *no check valve is opposing the air discharge* from the outlet side of the pump. Also a scavenger or oil pressure pump with lubricated gears and manufacturable clearances, that has to dispose of inlet air before the bulk of oil reaches the gears *will not prime* when a check valve at the outlet side retains a back pressure greater than the air pressure that the pump can produce.

Briefly the successful pump designer and manufacturer should reduce gear clearance to a minimum; suction head to a minimum and check valve pressure to a minimum and also provide lubrication for gears. The oil cooler manufacturer should either refrain from using check valves to control temperature of oil cooler or provide *large air valve* or orifice for quick discharge of air from scavenger pump during priming time.

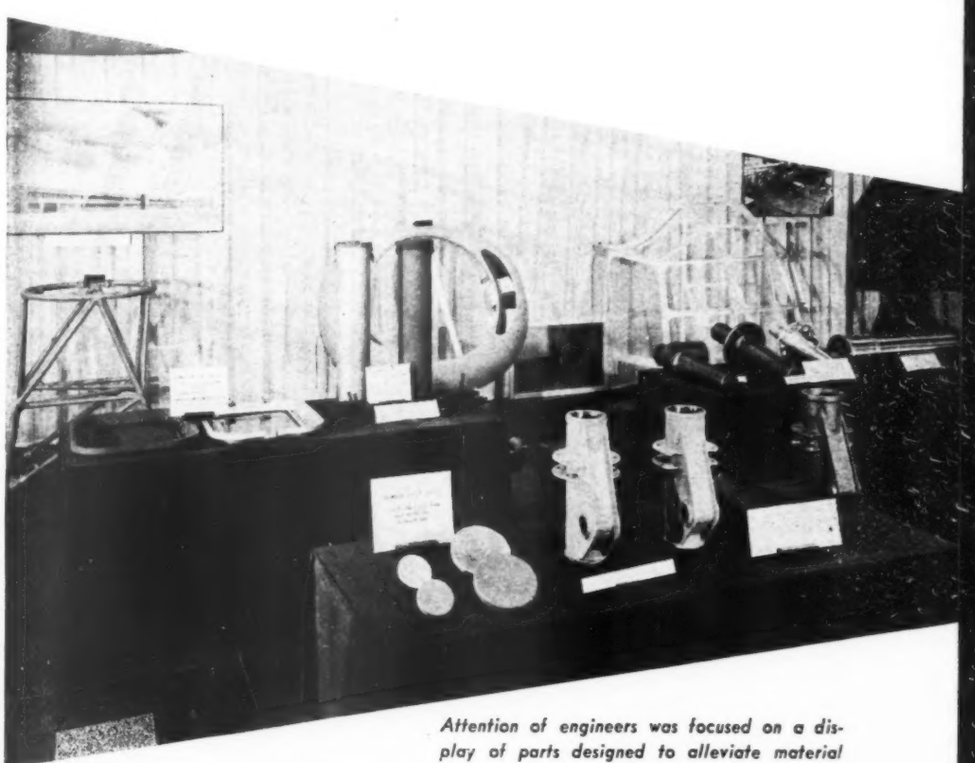
Oil Supply Tanks

Here are some of the facts learned about tanks during these tests. Some pendulum types of oil tanks have been found satisfactory for slow roll, dive and climb with 30 percent oil in the tank. Tanks without pendulum are not satisfactory in the roll maneuvers. Tanks with large horizontal dimensions relative to vertical dimensions are not satisfactory either in dive or climb. Oil tanks for pursuit airplanes should be capable of maintaining an oil supply in all flight attitudes which the airplane can make, including slow barrel rolls.

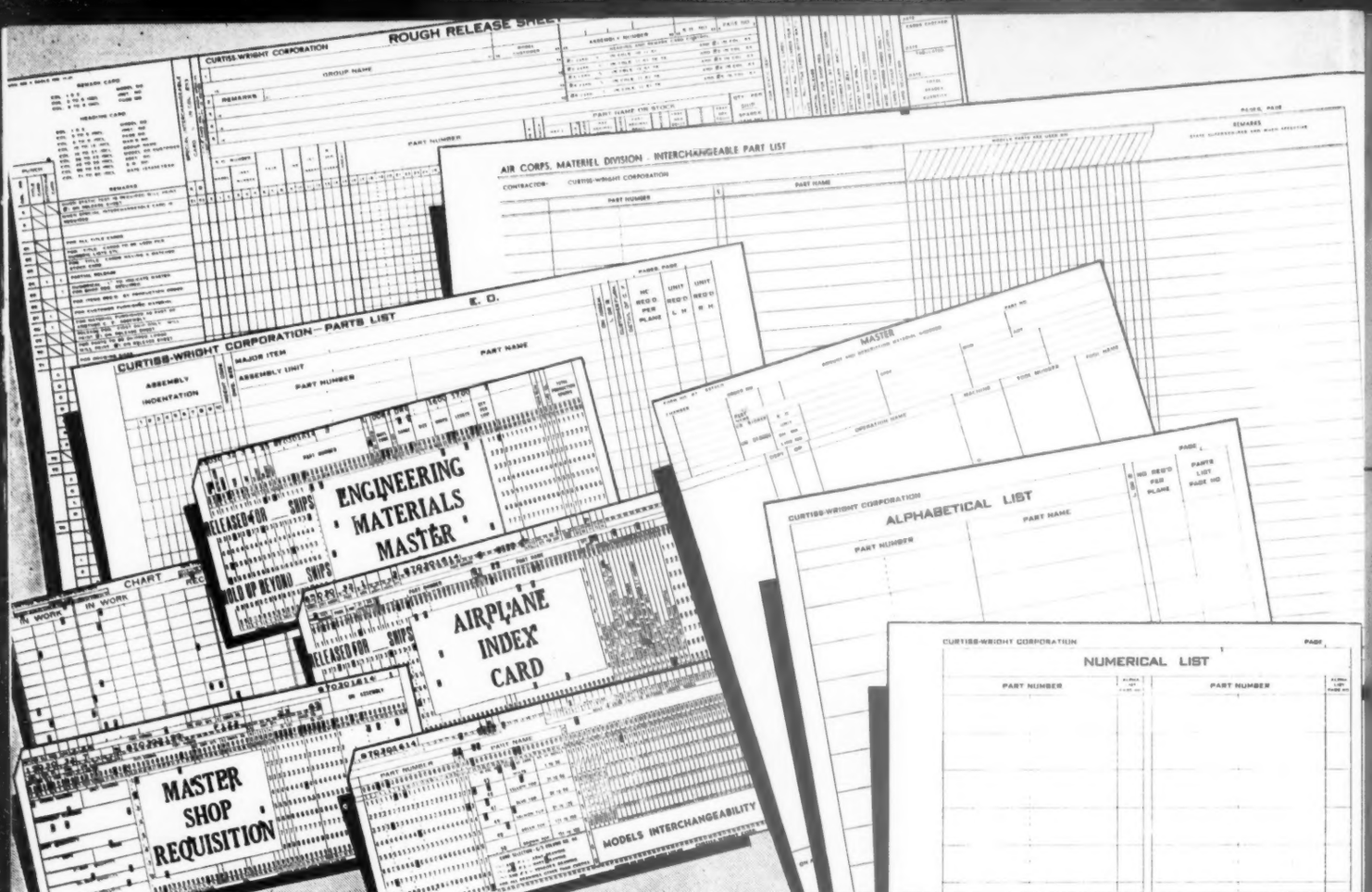
H. C. Karcher, also of the Allison Division, emphasized the need for aircraft manufacturers to follow engine manufacturer's installation specifications. Streamlining of the fuselage has required the shrinkage of frontal area and the removal of many engine accessories to remote parts of the airframe. Oil lines had to be lengthened and compromises made to maintain air balance. These changes have been very embarassing to the engine manufacture who has been called upon to explain engine failures, due to lack of lubrication. In every case of engine oil pressure difficulty which has come to our attention, satisfactory operation has been attained by cooperative study. This is mandatory during a critical war period.

One case was related by Karcher where the engine manufacturer's oil inlet line of 1½-in. diameter was reduced by a fitting drilled to only ¾-in. diameter. By increasing the oil supply line ¼ in. and providing a new streamlined fitting a substantial gain was obtained in flight test. Removing ½ in. from the hopper sump sleeve gave an additional gain. This increased the effective make-up oil head and raised the hopper level so that time for de-aeration was lengthened. Relocation of the temperature indicator bulb which protuded into the oil line at a critical point also improved the performance. In test flights the trouble recurred and this time it was found that the new fittings had been designed with too light flanges and that normal wrench torque warped them out

(*Turn to page* 323)



Attention of engineers was focused on a display of parts designed to alleviate material shortages, reduce production time, cut down aircraft weight, shorten production time. These include plastic materials to replace aluminum and steel castings, including some made by centrifugal casting methods, which replace forgings and thereby free forging equipment for other necessary work. In the background are a bomber cowling of spot-welded aluminum alloys and an aluminum alloy stamping used for bombardier's enclosure. The parts illustrate instances in which manufacturing methods and tooling have been changed to accommodate increased production quantities. The cowling formerly was riveted, and the stamping made in smaller parts and assembled to form frame.



Engineering Release For Mass Production

By L. N. PIZZUTO

Release Engineer, Airplane Division, Curtiss-Wright Corporation

MORE THAN FIVE YEARS ago it became evident that our existing release system could not meet the problems created by the accelerated volume of business and the numerous changes in designs and construction methods occurring during the time of production.

It also became necessary to avoid the disruption of engineering schedules through the assignment of personnel to the manual compilation of bills of materials and to the preparation of parts lists, price lists, lists of drawings, etc., and it became further necessary to establish satisfactory control over the rapid accumulation of data originating from changes in design.

The increasing need for more production in less time dictated the necessity for getting production orders to the shop with the least possible delay. The need for lot release controls became apparent to avoid the production of shelf stock which would soon become obsolete with design changes, making it necessary to rework or to scrap full stocks of these finished parts.

When the production of an order was finished, the problem of completing the changes in the records of the parts and drawings actually used in the construction of this job was so large that delays and inaccuracies in the preparation of the parts list catalog seemed almost inevitable.

The prospect of a tremendous increase in the personnel required for the manual writing of work orders and for the preparation of numerous lot releases to the shop, suggested the mechanization of the procedures.

As a result of considerable study, the release section of the engineering department was established and the pres-

ent release system was inaugurated with the application of the electric automatic recording and accounting machines of the International Business Machines Corporation to the procedure.

A single transcription of the data to the electric accounting machine card in the form of punched holes, and the verification of the accuracy of the transcription, by the use of a standard keyboard machine, are the only manual operations necessary to establish an accurate unchanging record of the production item.

Card records are automatically sorted to sequence according to the grouping arrangement desired and the printed transcript records are automatically prepared at the rate of 80 lines per minute.

The punched card records with the electrical accounting machine are used automatically to produce the printed release sheets, release sheet changes, bills of material, parts lists, index file records, etc.

The use of the original card for all these purposes assures complete accuracy and perfect agreement of the data for an item of detail in all the transcripts and file records in which it is recorded.

Thousands of items are specified in the production of an airplane and the transcript record for a single item was repeated many times in the writing of:

Shop Function

Shop Release Records
Production Order Records
Work Orders
Material Requisitions
Chart Card Forms for the record of production by the "crib" personnel of the shop department

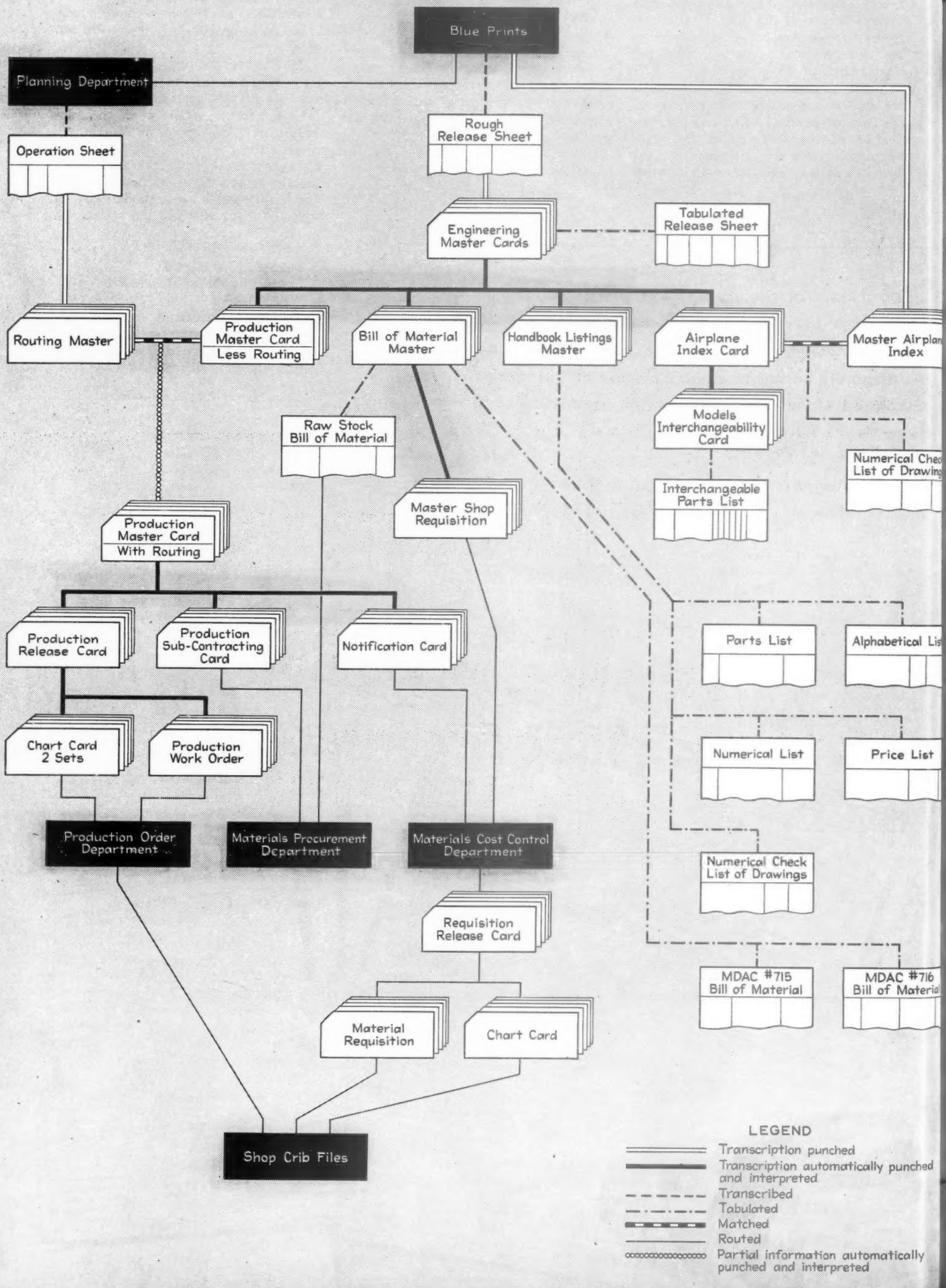
Engineering Function

Preliminary Parts List
Engineering Order
Alphabetical Order
Numerical Order
Price List in Numerical Order

(Text Follows Chart)

The masses of military airplanes that are flowing out the back door of the nation's aircraft plants represent an incredible amount of detailed paper work. Before a single plane rolls off the assembly lines, the greater portion of this work must be completed. Upon the rapid, accurate completion of this work depends the flow of production. Two specialists in mass production, the Curtiss-Wright Corporation and the International Business Machines Corporation, got together on this problem and the following story tells what they accomplished and how.

CURTISS-WRIGHT ENGINEERING RELEASE SYSTEM



The Curtiss-Wright Release System Sets the Entire Production Machinery in Motion from Materials Requisition to Assembly

THE BLUEPRINT SECTION OF THE ENGINEERING DEPARTMENT prepares and distributes blueprint copies of the drawings to be used in the production of the order, to the production planning department and to the release section of the engineering department. The production order section of the planning department prepares from the blueprints, the Operations Sheets to cover the fabrication of the items and also establishes a file of Routing Master cards from the Operations Sheets for the record of the routing of each item through the manufacturing departments of the shop. The Routing Master file consists of one electric punched card for each item, prepared from the first Operations Sheet made for the item. New Routing Master cards are added to the file only when the new Operations Sheets are made for items not previously specified and used in the production of other orders.

The file is used for reference purposes and also for the automatic reproduction of the punched routing data from the Routing Master to the Production Master cards as will be later described in these lines.

The release section of the engineering department checks its blueprint copies with the Master Index Record of Drawings which is maintained on electric punched cards, to determine whether the drawings previously have been used for the production of other orders. The Master Index record consists of one card for each drawing currently in use throughout the organization and the card record carries the reference to the part number, part name, drawing size, and drawing change letter. These cards are filed in part (drawing) number order and new cards are added to the file only when the blueprints cover items not previously used and for which there are no cards in the file. The Master Index record file is used for reference purposes and also for the automatic tabulation as later described, of both the preliminary and the final Numerical Check List of Drawings for the order.

When the check of the blueprints with the Master Index Record of Drawings has been completed, the release section prepares the Engineering Master cards in the manner determined by the blueprint check, depending on whether the drawings have previously been used. If the drawings have not been used before, the blueprint data is analyzed and transcribed onto a Rough Release Sheet form for the manual preparation of the new Engineering Master cards. If the drawings previously have been used for release of other orders, it is not necessary again to analyze and transcribe the blueprint data. Instead, the Engineering Master cards from a previous order automatically are used to duplicate a new set of master cards for the new order.

The Engineering Master cards are the basic records of the release system. They are used for the automatic tabulation of the Release Sheets and are subsequently used for the preparation of four primary function cards which are obtained by automatic reproduction of the punched data from the master to the function cards.

The first of these is the Production Master card which is prepared only partially from the Engineering Master card and is then collated with the Routing Master card file of the production order department. The routing data from the Routing Master cards is automatically reproduced to the Production Master cards. The Production Master cards are finally completed by the automatic extensions and punching of the lot quantities and the total quantity of each item required in the manufacture of lots and for the completion of the order. Three more release cards relating to production are obtained by automatic reproduction of the punched data from the Production Master card. The first of these is the Production Release card from which Production Work Order cards and Chart cards automatically are obtained and are sent to the production order department where they are in turn passed on to the shop crib files. The second card obtained from the Production Master card is the Production Subcontracting card for purchased and standard items. This card is sent to the materials procurement department where appropriate action is taken to get the items into stock for use as they are needed. The third card is the Notification card which is sent to the materials cost control department for its record of purchased and standard parts to be supplied from stock to the production line of the shop, for fabrication and assembly.

The second primary function card obtained from the Engineering Master card is the Bill of Materials Master. A raw stock bill of materials in transcript form, automatically tabulated from the Bill of Materials Master cards, is transmitted to the materials procurement department for its use in anticipating the replenishment of the stocks. A Master Shop Requisition card for purchased items also is obtained from the Bill of Materials Master card. The Master Requisition cards are sent to the materials cost control department where they are verified by identification with the assembly specification sheets for such items. After verification, a Requisition Release card is prepared for the file of the materials cost control department by automatic reproduction of the punched data from the Master Requisition card. From this Release card file, Material requisition cards and Chart cards automatically are obtained and both are sent to the shop crib files.

The third primary function card obtained from the Engineering Master is the Airplane Index card. This card is collated with the Models Interchangeability card which carries an accumulated record of the use of an item in all the previous orders. The Interchangeability card also is punched to show the use of the item in the order which is now being released. Interchangeable Parts Lists automatically are tabulated from the Models Interchangeability card file. The Airplane Index card file is maintained in the sequence of the installation, page and line number of the release sheets on which the items appear, for each part number, and this file is used for reference purposes at any time to determine what releases of an item have been made to apply on the order being released.

The fourth and final primary function card obtained from the Engineering Master card is the Handbook Listings Master card. These cards are prepared only when the release has been fully completed and the entire file of Engineering Master cards for the order has been accumulated. The Handbook Listings cards are used automatically to tabulate the preliminary Parts Lists and again, when the construction of the job has been finished and all the changes have been worked into the Engineering Master card file, the file of Handbook Listings cards is adjusted to correspond and is used automatically to prepare the final Parts Lists and catalog indexes. The Handbook Listings cards also are collated with the Master Index Record of Drawings file, automatically, to select from the record of drawings file the corresponding cards. The selected Record of Drawings cards are used automatically to tabulate both the preliminary and the final Numerical Check List of Drawings.

Final Parts List
Engineering Order
Alphabetical Order
Numerical Order
Price List in Numerical Order (Revisions)

In the above there are 13 basic transcriptions for the record of a single item of which there are thousands. Verification of each transcript to assure complete accuracy and agreement in all the records, of the part name and part number, required a tremendous amount of clerical effort and resulted in unavoidable delays to make corrections.

Under the present system, with the use of a single master card, the previous repetitious manual writing and rewriting of the record for an item of detail is eliminated.

Releases to the production order department are now made in from one to three days as compared with the time of from one to two weeks required under the previous system and complete bills of materials can now be produced within one or two days after the final release of the order, whereas the time of six men from four to six weeks was previously required to do this work.

All the changes in specifications are promptly incorporated into the release records. When the production of a job has been completed, the original cards which were used in publishing Releases and Changes notices are removed from the files and are used for the preparation of the final parts list catalogs, price lists, etc. Therefore, the completion of this work is vastly facilitated by the automatic machine production of the transcript records, and of equal importance, there is an assurance of accuracy in the results that cannot be so readily and conveniently attained under any other method.

By way of important additional functions of the system, lot release controls are established and the fabrication of parts for shelf stock is eliminated. Release changes are published promptly, the new card records are placed in the files and the superseded records are removed to maintain a current status of the active files at all times.

This punched card system has also been extended to the automatic preparation and group set-up of production master cards, release cards, work order cards and chart cards, for the shop.

The above records, now automatically reproduced from the original punched cards at the rate of 100 cards per minute, were previously hand-written and manually sorted to groups.

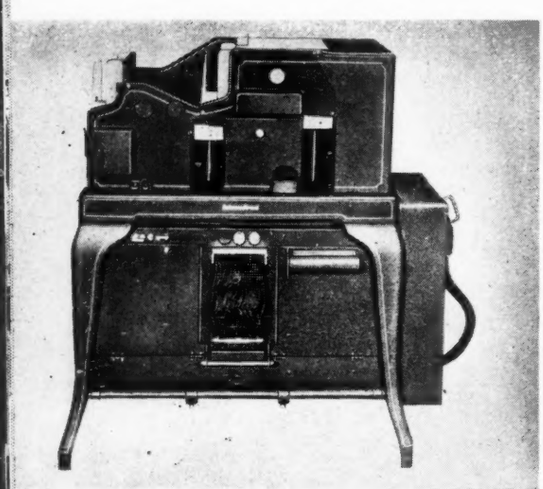
Among the many other functions of the system which previously could not be accomplished, due to the lack of sufficient time, are the preparation of:

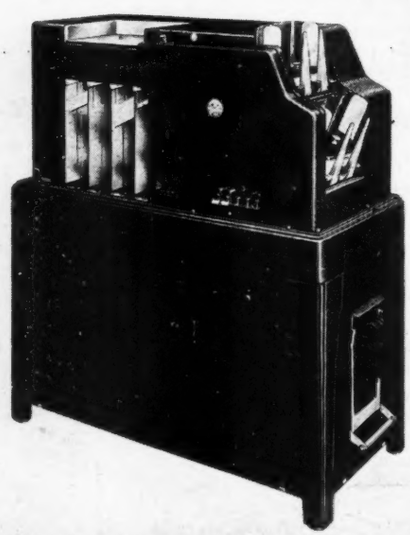
Purchased Parts List
Tool Schedule Report
Orders in the Shop (at any time)
Engineering Hold-Ups
Cancellations
Changes
Changing of Operation Sheets (Routing)

With the great increase in the volume of orders and the unusual demands of production during the past year or two, satisfactory release controls and other more efficient procedures have been maintained at all times, without comparatively large increases in personnel and equipment.

A casual glance at this engineering release system would lead one to believe that it is a complicated set-np. However, it must be borne in mind that the duplication of cards and the automatic tabulation of data sheets from the cards is performed with almost incredible speed on the International Business Machines. With this speed of duplication it is possible and economical to establish a number of controls that would not be feasible under a manual transcription system. Without such controls, materials, waste and time loss would be considerable.

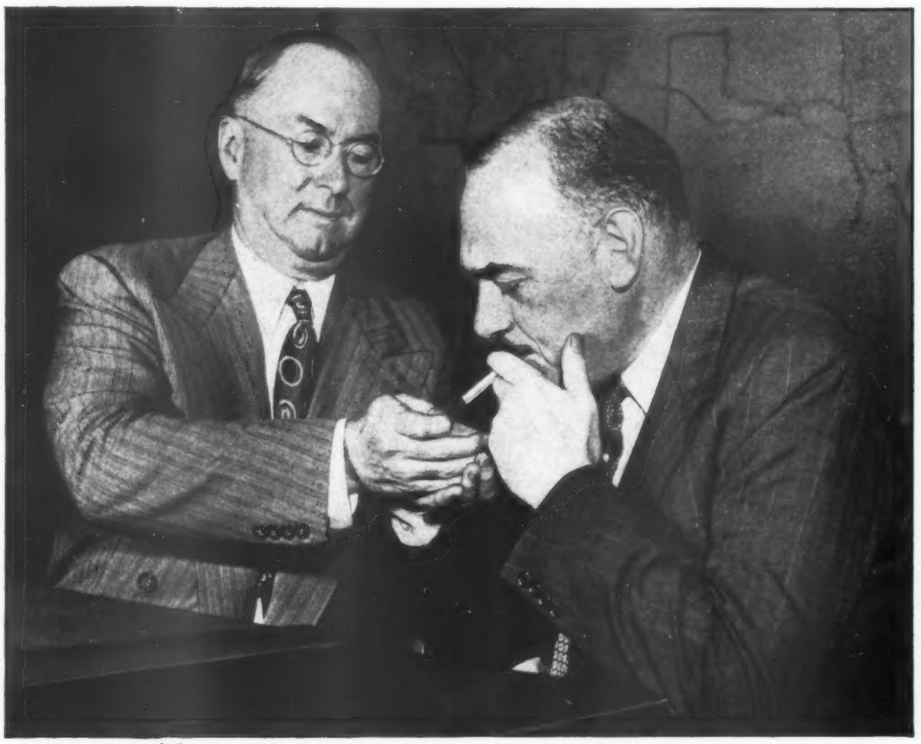
When one considers the volume of work done in the Curtiss-Wright engineering release section in keeping with the volume of production at Curtiss-Wright, it becomes evident that the compactness and orderliness of the installation and the minimum number of personnel require to do the work is a tribute to the efficiency of the system.





TOP: The IBM Automatic Reproduction Punch machine is the basic machine of the Curtiss-Wright engineering release set-up. All or any part of the punched data on one set of cards may be automatically transferred to another set in any desired sequence with this machine. LEFT: The IBM Collator is used for merging or matching files of cards in identical numerical sequence. In the Curtiss-Wright release system, the machine is used to match the Routing Master card with the Production Master. BELOW LEFT: To assure transcription accuracy, the Verifier machine detects any error that may have been made in the punching. BELOW CENTER: One of the very few manual operations necessary in the Curtiss-Wright release set-up is the punching of Engineering Master cards from rough release sheets. BELOW RIGHT: Tabulating Release sheets from Engineering Master cards at the rate of 80 cards per minute.

The Story That Must Be Told



Two men who know the story best: Donald Nelson, Chief of the U. S. War Production Board, and (right) Oliver Lyttelton, Great Britain's Minister of Production.

BETWEEN THE LINES of today's war news is written a story that is even more vital than the news itself. For through that story we begin to discern the pattern of victory, not yet complete in all its details but increasingly clear in its essentials.

It is the amazing story of how American industry has responded to the call for the weapons of total war, of how its technicians, workers, and managers are driving through an unprecedented task of fantastic size and complexity.

France fell in June 1940. During that month this country produced about $150,000,000 in war goods. By June 1941 the Nazis had overrun the Balkans; and in that month our war production was $800,000,000. The fateful month of December 1941 gave us an output of $1,800,000,000—an increase better than tenfold in eighteen months. And in May 1942 our total expenditures for war equipment and supplies mounted to the staggering total of $3,500,000,000.

This is an increase of twentyfold within two years, of itself a stupendous industrial achievement. But what is even more important, that achievement already is making itself felt the world over—in the Orient, in Australia, in Libya, in Europe, in the Coral Sea, at Midway Island, at the Aleutians, and wherever else we find a battlefront manned by free men.

To accomplish it, many industries have been pouring out war materials at a rate that only six months ago did not seem even remotely possible. Starting from scratch, our factories have turned from their peacetime jobs, first to meet and then to surpass the most hopeful estimates of what might be expected of them.

To do this they have drawn heavily upon all of their resources. Their skilled and unskilled

man-power has thrown into the task a war-born will to work; their research staffs have bent to it all of their scientific resources; their engineers have applied to it their utmost ingenuity; their executives have devoted to it the full measure of that managerial skill which has won for American industry the respect of the modern world.

For the first time in history we have pushed the accelerator of the world's greatest engine of mass production down to the floorboard. Always in times of peace, factory men have had to gear production to what the markets would take. But now the market they are called upon to serve is hungry for the last ounce of potential output. For war confronts industry with a demand limited only by its capacity to produce.

During these feverish months, while a desperate world has watched breathlessly to see how American industry would perform as the arsenal of democracy, we of McGraw-Hill have followed with mounting pride — at times almost with wonder — a new miracle of industrial achievement.

Some day the full story of this American industrial effort will fill a brilliant chapter in the epic history of our times. Meanwhile it would be premature to celebrate the completion of this task. For victory has not yet been won; that still lies at the far end of a road that we may find to be long and arduous.

But even now we can be certain of one essential of that victory. American industry is doing its job; it is delivering all that the people have asked of it — and more.

As I have watched with my associates the unfolding of this picture, I have wished that it were possible to broadcast it, in full color and wealth of detail, to the people of America, so that they could understand at least, in part, the job their industry is doing for them. It would help, it seemed to me, if the men of industry themselves, each so intent on his own task, knew what their fellow-workers in other fields have been doing.

However, the managers of industry have been far too busy ***doing*** to talk. They are going to be just as busy for some time to come. Naturally, many details are yet to be spread upon the record and, indeed, the full story cannot be told. But that part of the story that can be told is well worth the telling and the hearing, if only for its revelation of the spirit of an awakened America, throwing its all into the fight against the tyranny that has brought so many of the world's little people under its heel.

The 1941 war production of the United Nations, exclusive of the United States, equalled the total 1941 war output of Germany with all of its captive plants and enslaved labor. Since Germany's 1941 operations were at maximum capacity no further increase is possible. British output has been expanding to the point where its 1942 production is considerably ahead of Germany's.

In May 1942 American war production passed the British output 50 days ahead of schedule. In 1943 it will be 3 times that of the British.

This has been brought about under the leadership of Donald Nelson and the War Production Board, the Army, the Navy, the Maritime Commission, with the cooperation of management and labor. It has been furthered by the cooperation of Oliver Lyttelton, British Minister of Production, and other British production authorities.

But the story goes far beyond that. It gives us a glimpse of the America as it will emerge from this war, its industries again setting world standards of production, which will become the spearhead of our post-war economy.

This is a story that cannot be adequately told in generalities. It must be told in some detail. For instance, the great accomplishments of the machine tool industry, the great forward strides made by the aviation industry, the tremendous achievements of the chemical industry, the amazing conversion of many industries will warm the hearts of Americans.

These aspects of the subject deserve the fullest treatment and will be told month by month in these pages until the story has been completely unfolded. We will try to give a concise overall picture of the war job that industry has done and still is doing. You will find it a thoroughly American story of high American achievement in which every American can take pride and from which every American can take hope for the future of his country.

The story is far too significant to be withheld any longer.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

This message is appearing in all McGraw-Hill industrial and business publications, reaching over a million readers.

Round trip to Tokyo

THEY DID IT!

They flew over trackless sea into the *setting* sun of Nippon!

They hit their objectives right on the nose and winged their way safely back to base.

How they did it is no small cause for wonder to the man who is used to following highway signs.

But to the skilled pilot who flies with precision instruments, the route is clearly marked.

Such are the instruments of every type built by Kollsman for fighting aircraft of the United States and Allied Nations.

U S. Army B 25 Bomber over Tokyo

Work Simplification Can Speed War Production

Existing plants and machinery could increase war production at least 50 percent, without overworking employees, the author maintains. He tells how this can be accomplished through the application of principles of work simplification.

By ALLAN H. MOGENSEN

BETTER USE OF MEN and machines could increase our war production now by at least 50 percent. This does not mean we have to overwork the men; this does not mean more speed; it means just using common sense.

Why do I say this? Because it has already been done by such firms as Vultee Aircraft, Du Pont, Johnson & Johnson, Johns-Manville, Bakelite, General Foods, Republic Steel and many others. It is being done right now by a few firms on the manufacture of aircraft, gas masks, military radios, explosives and ammunition. It could be done by every manufacturer in the country, and would help us to live up to and exceed the pledges made by the President and Donald Nelson.

How will we do this, you ask? By immediately training all workers in the simple fundamentals of work simplification. By overcoming the old superstition that man has been subdued by the machine. By again reaffirming the importance of man, so that we bring out not only the best of the machine, but the best of the man.

Unless we do this, it is doubtful if we can bring our output of necessary war materials up to surpass that of the Axis powers in time to avoid the loss of many lives.

If we run every possible plant that can be converted to war production 168 hr. a week, we still will fall far short of balancing the man-hour advantage of Germany and Japan.

This additional man-hour effort needed cannot be achieved by just employing more men. To add another twenty-billion man-hours yearly calls for eight million additional workers. This force is not available, and it is doubtful if it can be made available by training, upgrading, further employment of women, and opening new fields for negroes, in the time at our disposal.

Nor will going to a longer work week alone solve the problem. It is true that by adding new employees, transferring many more from non-war into war production, eliminating all work stoppages and extension of the work week we can add about six billion man-hours a year to our armament effort. But this is far short of the balance of man-hours we

We All Resist Change . . .

when pushed from behind . . .

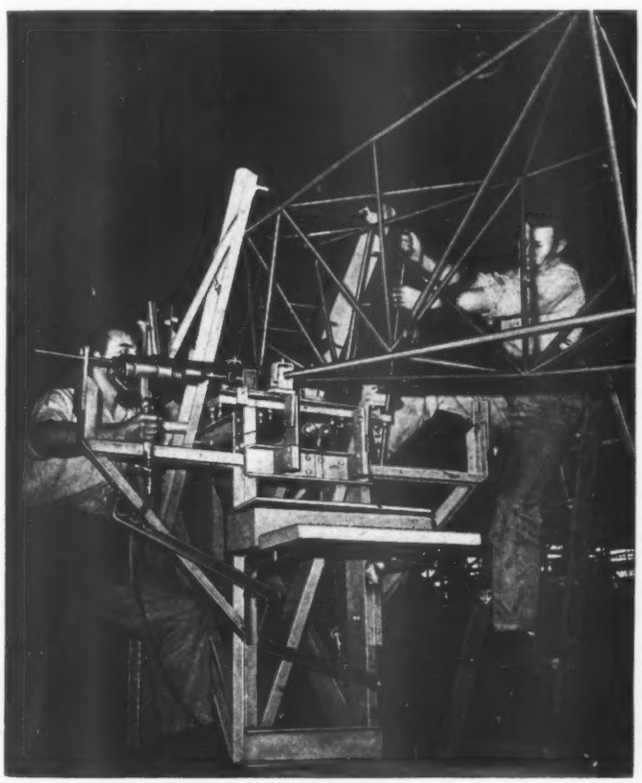
. . . or from the front.

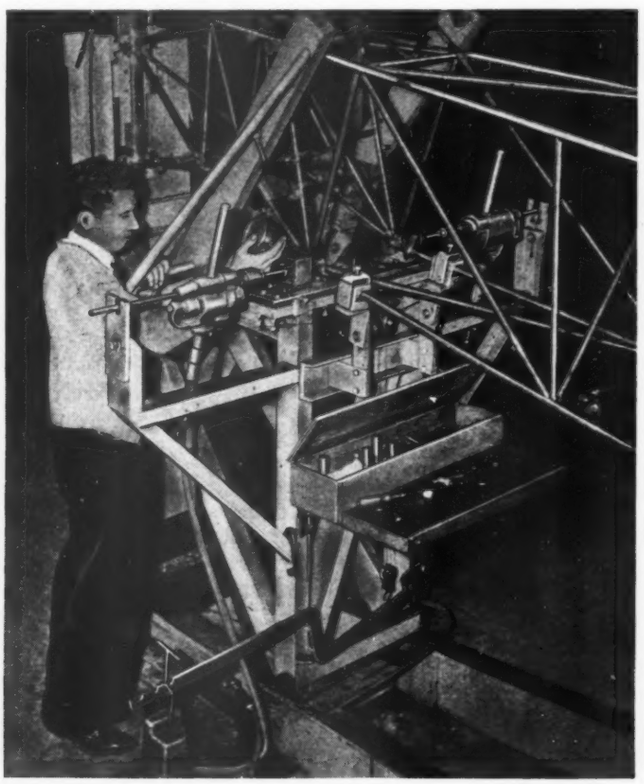
Fundamental of work simplification is to locate all tools, supplies, fixtures and machine controls within normal working areas as indicated.

Applying principle of "circular work-place" girls at Vultee Aircraft assemble terminal boxes in fraction of time formerly required.

Inclined Table Reduces Fatigue

Electric drill operators at the Vega Aircraft Corporation's Burbank plants no longer have to stretch or work in awkward positions, and production has gone up as fatigue went down, since the introduction of inclined top drilling benches and tables. The "Before and After" photos showing Jessie W. Baldwin demonstrating the old and new ways of doing her work tell the whole story.





Drilling Bushings for Tail Wheels

LEFT: Worker mounts air drill in bracket, connects air hose, while his assistant climbs ladder and places a piece of pipe to serve as a lever. Operation is repeated to drill bushing on the other side. RIGHT: Pulleys costing ten dollars are installed and attached to lever which actuates two drill motors at once. Time is reduced 80 percent and only one operator is needed to watch drills and apply cutting oil.

need to win this war of production.

And one grave danger of trying to run our production plant 168 hr. a week is that for a considerable time we will have to ask our foremen, supervisors and executives to work excessively long hours. This will result in a completely fatigued group of industrial leaders, and tired leaders don't get results. Immediately on the outbreak of the war of 1914-18 very long hours of work became the rule in Great Britain, not only for men but also for women and young persons. Early in 1915 it became apparent that while long hours could be worked with advantage for short periods, continuous overtime very soon produced lassitude in the workers and adversely affected the quality and quantity of their work. A reduction of hours in certain munition factories lead to an increase not only in hourly output, but also in total production. We should not make that mistake here. Over-time

is a temporary solution, but cannot be relied upon for the long pull.

Undoubtedly many people will want to work harder and produce more. However, wanting to do more is not enough. Few people know how to increase their output. Many of them will find themselves in the position of most industrial executives today—*too busy to be efficient.*

The answer is not to work longer, harder, or faster, but to increase our productivity. I do not say increase production. I say we must *increase productivity.* Please note this distinction. This does not mean working harder or faster, but means using our manpower and our machine equipment more effectively.

It means finding out the simplest way of doing each job, and the right way is usually the easiest way. We don't ordinarily do things the right way. In fact, the right way of doing anything is an art.

Usually we don't do things the right way until we have to, often only when it is a matter of life and death. Let me illustrate:

Can you visualize the scene? A patient lies on the operating table in a modern hospital. The surgeon has made the incision, and then he starts to hunt around for certain instruments. He exclaims frantically, "where are the instruments we need? Has anyone seen them?" "Oh, yes," someone says, "We had those up in the other operating room yesterday." "Well," says the surgeon, sitting down, "send some one up for them, we'll wait."

No, you can't visualize such an occurence, because it could not happen. In the operating room, every instrument is in place, usually two or three of each one. The surgeon does not stop work, look over the instruments and say, "Miss Williams, I think I'll take those large artery forceps over there." No, the instrument nurse has already anticipated his needs, has the proper one ready, and places in his outstretched hand without his ever raising his eyes. Why is this? Because here every fraction of a second counts, it is a matter of life and death.

The story is told of a famous surgeon who was to perform a serious operation. Every second counted. Before starting, he turned to his assistant and said, "Time is of the essence—Let's not hurry."

Walter Dill Scott, president of Northwestern University, has said, "It is more than probable that the average man could, with no injury to his health, increase his efficiency 50 percent." Walter Pitkin says, "You can double your efficiency after a little training."

Not one person in a thousand understands the laws of motion economy as applied to human effort, and of those who understand these principles, not one in a hundred practices or applies them. These principles, developed many years ago by Frank B. Gilbreth, are so simple that when they are properly presented most people exclaim. "Say, that is just plain common sense." Yet in even the most efficient manufacturing plants you find them being violated on every hand.

To illustrate this, let us take one of these principles. This is based on the well-established fact that if one uses a full body movement instead of a finger or wrist movement, the operation takes longer, is far more fatiguing, and is less accurate. Applied to a workplace with the operator in a seated position, we find that the hands and arms describe two sets of working areas. Yet despite this obvious fundamental, most of our tables, desks, workbenches, and machines are designed incorrectly.

As an illustration of this, the piano keyboard has always been arranged in a straight line. This was of course made necessary by the mechanism involved. As a result, the motions used in playing a piano are complex. The keyboard of the old-fashioned church organ was similar to that of the piano. However, when they came to design the modern theater organ, they wrapped the keyboard around the organist, thus applying principles of good motion practice.

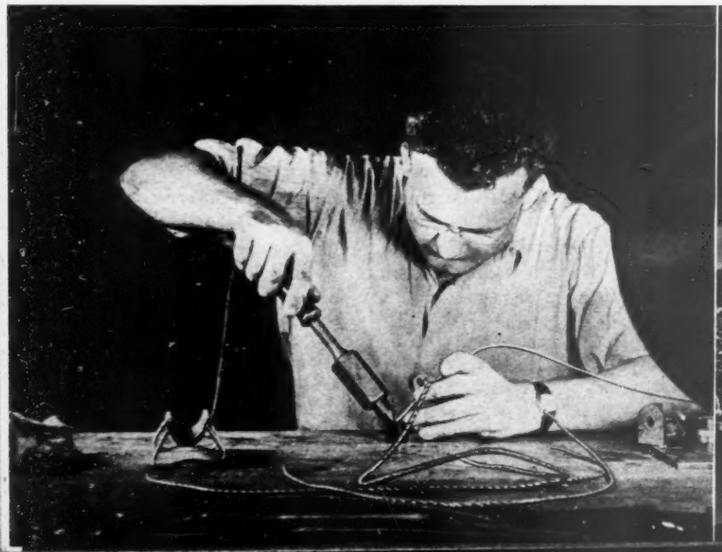
A few of our most modern industrial plants, banks and offices have applied this principle in the design of their

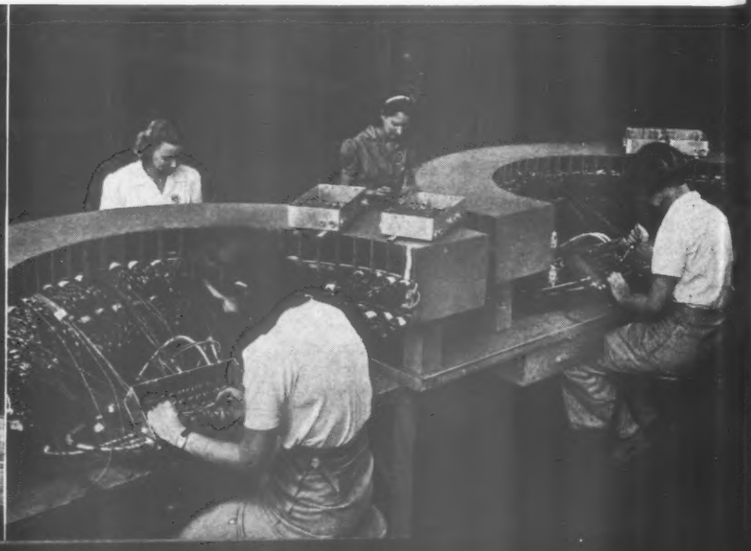
(*Turn to page* 310)

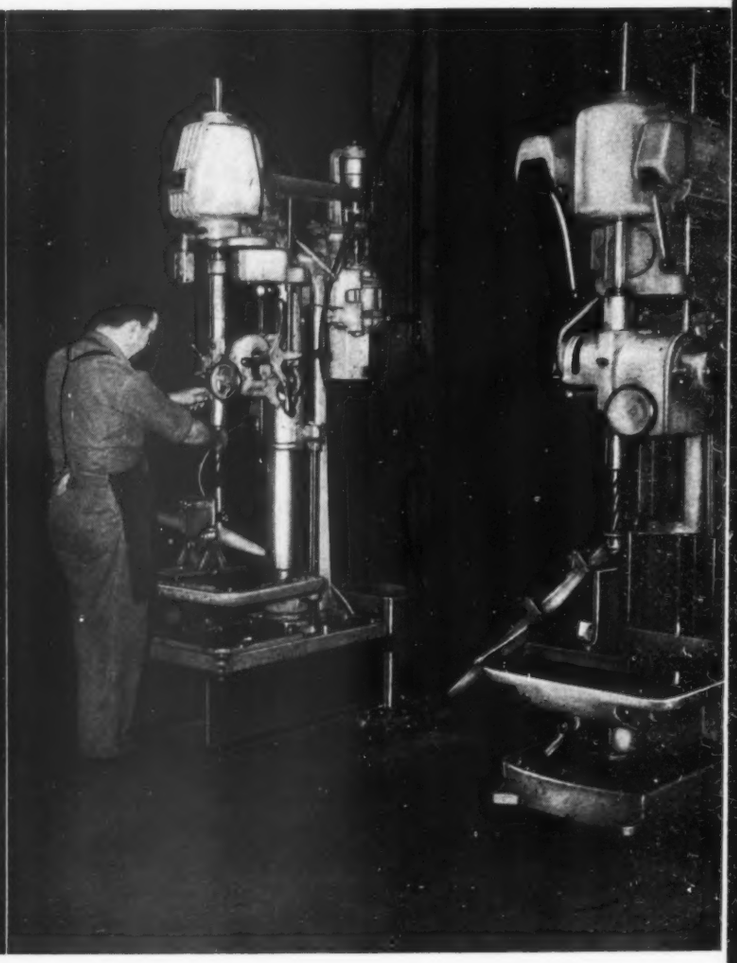
The Japs have been **applying principles of work simplification for many years. Mr. Mogensen reports that in 1931, without permission, they translated his book *Common Sense Applied to Motion and Time Study* into Japanese. A friend who visited Japan in 1935 told him that in one plant they had applied motion economy principles to wrapping soap so well that their costs were far below those of the most modern American automatic wrapping machine. Similarly, Germany has made intensive studies of all sorts of jobs with the motion picture camera in an effort to improve methods.**

Assembling Electrical Parts

With materials scattered inconveniently on the work table, man on left must use one hand to hold part while right arm is held in an awkward position. Circular workplaces used by girls at right place all materials within easy reach, while terminal box to be assembled is held in fixture, tilted at proper angle, freeing both hands to work in convenient positions. This orderly set-up eliminates confusion and speeds assembly.







Drilling Landing Gear Struts

Many good work simplification ideas come from workers themselves. A drill press equipped with automatic feed takes three minutes per cut in drilling holes in landing gear struts at Stinson. At the suggestion of the operator, another drill was provided to permit him to ream another hole in the same part while drill was working. As a result of this idea, output was more than doubled.

Assembling Air Buffers

Methods of assembling an air buffer at Vultee are studied by Foreman Dick Megorden, with J. M. Druliner checking time required (left). Scattered materials and use of vise slows operation. From the study resulted a special jig holding 35 assemblies. Small parts are held conveniently in bins in front of operator. Now, work goes much easier and time required is shortened by 46 percent.

We're signing this pledge
By Thousands
TO HELP AMERICA BUILD A PLANE EVERY 8 MINUTES
Pledge of the Aircrafter
To the end that American war plane production may reach the rate of one every eight minutes or a total of 60,000 for 1942—
To the end that there not be "too little, too late" on the battle fronts where our fighting men are offering their lives for the preservation of my country—
I solemnly pledge my full support to the great objectives of the Joint-Labor Management Production Committee of Goodyear Aircraft Corporation.
Robert Moon
Signed

FOREWORD: *In April a Joint Labor-Management campaign was launched at Goodyear Aircraft Corporation in cooperation with the War Production Board's drive to attain the President's goal of 60,000 warplanes this year. Its slogan: a plane every 8 minutes will put the Axis behind the 8-ball. The following advertisement, recently published in Akron papers, tells how Goodyear aircrafters responded.*

THINGS have been happening fast here at Goodyear Aircraft since the big "Plane-Every-Eight-Minutes" rally a few weeks ago.

Telling us how we could help put Adolf, Hirohito and Bennie behind the 8-ball has given us a real mark to shoot at.

Thousands have signed the Aircrafter's Pledge to do their best to help America produce 60,000 warplanes this year—*a plane every 8 minutes.*

Every pledge was signed voluntarily, the American way.

Suggestions for bettering our work, eliminating bottlenecks and saving materials are pouring in, too—50,

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AIRPLANE INDUSTRY

1. *By building parts to manufacturers' specifications.*
2. *By designing parts for all types of planes.*
3. *By re-engineering parts for mass production.*
4. *By extending our research facilities to aid the solution of any design or construction problem.*

"LET'S GO! U.S.A." "KEEP 'EM FLYING!"

60, 70 and more every day. Many of them so good, it's going to be mighty hard to pick the Grand Award Winners.

And it's inspiring to see the daily work-progress thermometers many assembly crews have put up on their jigs, to show how far ahead of schedule they are.

You'd get a kick, too, from the slogans everybody is contributing for the "Nippo-Nazi Say" posters all over the plant. Bull's-eye bell-ringers like "Stay out late with Mama, please Yokohama"—or "Make more scrap, no hurt Jap."

That's the spirit out here at Goodyear Aircraft. We're on the march, making every minute count more in doing our share of the work necessary to deliver a plane every eight minutes — *to make America first in the air.*

For we know that until our airmen rule the skies, neither life, liberty nor pursuit of happiness will be secure in this world again.

We repeat, this is our war, too — and as soldiers of the production line, we're pledging our finest effort to help win it.

Berlin, Rome, Tokyo papers, please copy.

JOINT LABOR AND MANAGEMENT COMMITTEE

W. E. Fowler
A. C. Michaels
Co-Chairmen

GOODYEAR
AIRCRAFT

Each morning, sharply at eight o'clock, Asst. Works Manager Harvey C. Christen, who has charge of the Lockheed expediter system, meets with his day-shift expeditors, giving out new assignments and checking on those still in progress. It is here that the men ask and answer questions, enlist the help of others who are specialized in phases of a problem with which the assignee is not familiar, and otherwise organize their day's work. As the conference ends, in a matter of minutes after it begins, the expeditors scatter to all parts of the plants, on their assignments. They are all-around men who know the entire Lockheed system, but each is also a specialist.

Lockheed Expediter System

The mass production technique developed within the aircraft industry incorporates a degree of flexibility heretofore unknown. This means constant change and improvement in the end product while maintaining schedules. The expediter department, or equivalent system, is a by-product of this new production technique.

By HARVEY C. CHRISTEN

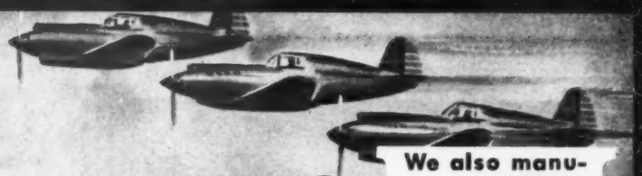
Asst. Works Manager, Lockheed Aircraft Corp.

A "RELAY RACE" that breaks production bottlenecks and efficiently attends to those hundreds of little, annoying odd-jobs that constantly bob up and demand immediate attention around a busy manufacturing plant, is the way we like to describe our Expediter System here at Lockheed Aircraft Corporation. The system is the result of trial and error methods that began in 1938 and is operated now with twelve expeditors who work together as smoothly as a college relay team. What they do ranges from breaking production bottlenecks to running errands. And their methods run the gamut from direct action to applied psychology.

Because of the almost innumerable kinds of work the expediter department does, it is virtually impossible to list or describe its functions without liberally mixing in the expeditors and their backgrounds. After nearly four years of experiment and testing, of successes and failures, it is my conviction that it is largely the personnel of this group that makes the system possible and valuable. For that reason it seems best to illustrate its functions with typical incidents of work actually done by the men.

Originally the group was set up, piecemeal, to solve bottleneck problems current at the time. The man assigned was selected for his knowledge of conditions surrounding the problem and was drawn from the Lockheed department most likely to understand all of its angles, and be in the best position to work out the solution. It was expected that once a jam was broken, the man would no longer be needed and would return to his regular work. For that reason he was not detached from the staff of his department, and instead, was merely loaned to this department. Later developments proved this loan arrangement excellent for liaison purposes, so it has become a permanent arrangement. While known as expediters, all twelve men are members of the engineering, fabrication, assembly, tooling and other departments. Their salaries are charged to those departments. And, if we should no longer need a man, he will return to the job from which he was originally taken.

All twelve are all-around men, likely to draw any assignment that comes along, but each is also a specialist in one or more types of problems. Each knows the entire Lockheed system, in

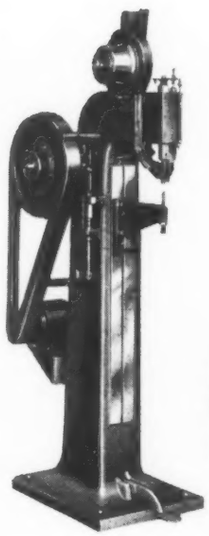


A COMPLETE LINE OF AUTOMATIC RIVET SETTERS

For Aircraft Production

We also manufacture a full line of INDUSTRIAL Single and Multiple Automatic Rivet Setters

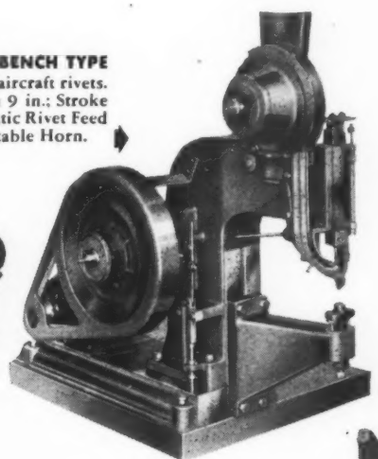
THROAT DEPTH RANGE FROM 6" TO 45"

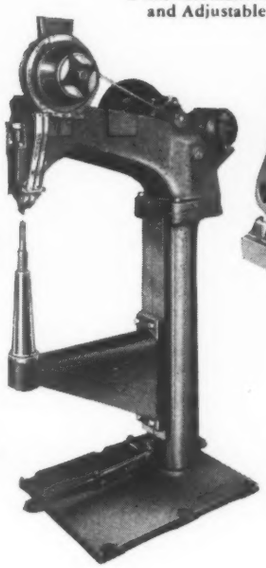


MODEL 121 FLOOR TYPE
Sets 3/16 in. aircraft rivets. Throat depth 9 in., Stroke 2-2½ in.; Automatic Rivet Feed and Adjustable Horn.

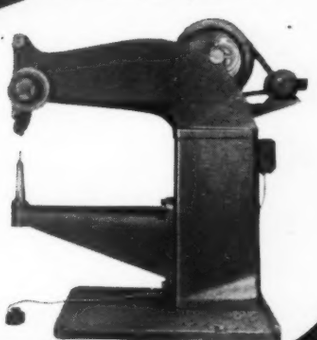
MODEL 90 FLOOR TYPE
Sets 3/16 in. aircraft rivets. Throat depth 12 in.; Stroke 2-3¼ in.; Automatic Rivet Feed and Adjustable Horn.

MODEL 71 BENCH TYPE
Sets 3/16 in. aircraft rivets. Throat depth 9 in.; Stroke 2 in.; Automatic Rivet Feed and Adjustable Horn.

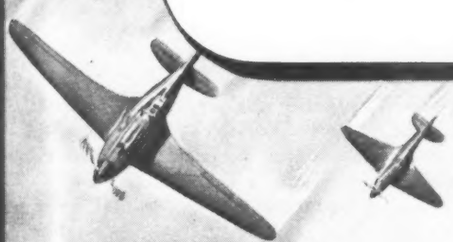




MODEL 140PT POST TYPE
Sets 3/16 in. aircraft rivets. Throat depth 24 in.; Stroke 2-3 in.; Posts 6 to 18 in.; Automatic Rivet Feed and Adjustable Horn.



MODEL 150 FLOOR TYPE
Sets 5/16 in. aircraft rivets. Throat depth 45 in.; Stroke 2-4 in.; Automatic Rivet Feed and Adjustable Horn.



WE'RE ready to help speed up airplane construction with a complete line of eleven machines for automatic setting of aluminum aircraft rivets. Throat depths: 6, 8, 9, 12, 24 and 45 inches. Production rates, up to 2400 rivets per hour . . . The clinch of automatic set rivets by Chicago Rivet Machines will meet all requirements of army and navy specifications . . . Our riveting production experts will be glad to make specific recommendations for your particular needs. To save time, please send blue print or sample assembly when inquiring.

Chicago RIVET

CHICAGO RIVET & MACHINE CO., 9614 West Jackson Blvd., BELLWOOD, ILL.

all plants, is familiar with every department, acquainted with department heads, and knows exactly who to work with on each type of job. And, what is just as important, each one takes an aggressive interest in getting a job done, by the quickest and most permanent method, even if that entails turning over all or part of it to another expeditor. They work singly or in teams, generally asking for the teammate best fitted to handle phases for which he is better qualified, and pass along the work like a relay team passes along the baton.

To promote this teamwork, the group has athletic and social functions every month or six weeks, at which informality, good natured ribbing about mistakes, and practical jokes are the rule. These parties have contributed considerably to the mutual understanding upon which teamwork is based.

Specialties of the men have been allowed to develop naturally, without suggestion or orders. Their backgrounds prompted assignments that have later led to specialization. As each man becomes adept at handling a particular type of assignment, calls for such help are automatically turned over to him.

Requests come to the department's office by telephone or directly from the teletype machines, in cases of emergency, or written on routine forms if the problem is not too urgent. Whatever the route, the flow is constant, day and night, Sundays as well as week days. During a recent two hour period, from 10 a.m. until noon, while material for this article was being discussed, nearly thirty requests for assistance piled up. All were about matters that were too urgent for routine, or for which there can be no routine.

A good example of what the system is and how it functions would be an approaching shortage of a part being installed in final assembly. Through some error or accident, let us say, the stockroom reported its reserve depleted and more are urgently needed on the line. Being a general problem it is likely that Expeditor Ray H. Hildebrandt would draw it. He is a former radio technician with 3½ years of Lockheed experience, loaned to us by the wing and aileron sections of final assembly. In 1-2-3 order, he would:

(1.) Check out blueprints, and verify that they were the latest ones. (2.) Check procurement and issue a "snap out" order for the materials, directing that they be sent to the proper starting point—or taking them himself if necessary and physically possible. (3.) Order, or himself make, necessary tool deliveries. (4.) Write out and personally deliver a job order to the starting-operation department, attaching an "Expedite", red, white and blue striped tag to it, and notifying the foreman of that department that a "hot" job is going through. (5.) Order the traffic department to follow through until the finished parts are finally delivered to the point of use. (6.) Check back to make certain they were delivered. (7.) Determine why the shortage occurred and reestablish the routine for its steady future flow, or recommend corrections of whatever phase of the system caused it to fail. (8.) Write out a complete report about the matter, for our expediter office files, and send copies to whatever other departments should know about it.

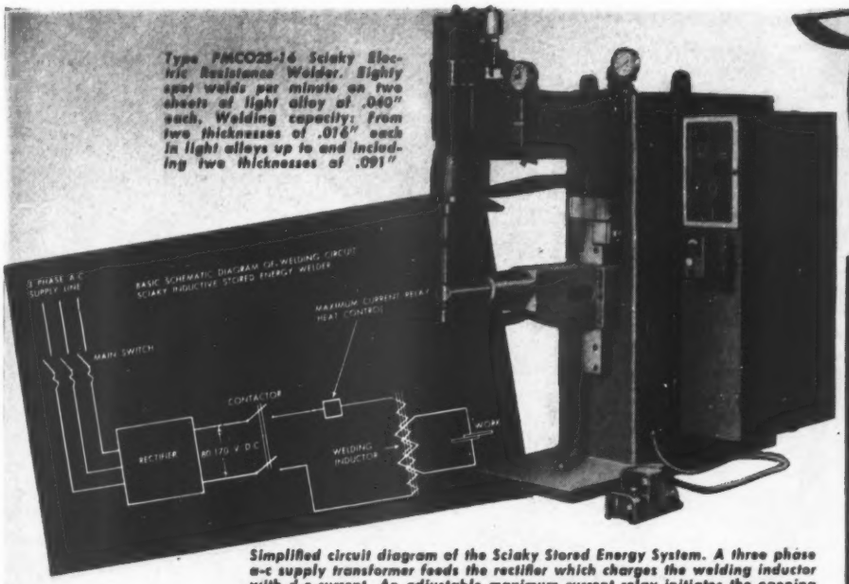
When the War Department notified us to immediately discontinue the round, red center of United States aircraft insignia, the order came to this department direct from the teletype room. The expeditor immediately telephoned the airfield, cancelling delivery flights until the red spot had been painted out of all insignia. Then he phoned the foreman of the painting department and gave the order, in each case, indicating

(*Turn to page* 317)

FIG. 1. Foreman Garland Fitzpatrick of the Lockheed fabrication department, who has just received an "Expedite" order, listens while Expeditor Robert W. Svihus, of the experimental department and a practical expert on the Lockheed P-38, explains the reasons for the rush order. Svihus had just come from the experimental testing laboratories where he obtained full information on the problem by watching the tests and assisted in the practical phases of the change he is explaining to Fitzpatrick. FIG. 2. A Lockheed expeditor, Jack Malone, of the final assembly department, hands a rush order with its red, white and blue striped "Expedite" tag attached, and a substitute intake duct to Todd Oviatt, foreman of an outside final assembly section, in this instance where both the order and part were delivered in person by the expeditor. The expediter system functions in such instances only where time savings and the exceptional nature of the demand makes it imperative to short-cut the usual routine through which such a part would be delivered. FIG. 3. Expeditor Yale E. Thompson, of the Lockheed engineering department, frequently draws rough sketches of changes that must be made at once, as he is doing in this instance. If the urgency requires it, he will order and supervise mockup and tooling and get the changed part into production before submitting his rough sketch back to engineering where it will be redrawn in permanent form for later, routine handling of future production of the part. Being both a graduate and experienced engineer and a practical shop man, Thompson can and does combine both accepted design practices and the latest, practical shop methods in his on-the-scene sketches and "Expedite" orders.

AMAZING POWER COST SAVINGS

WITH THE SCIAKY* PROCESS FOR SPOT WELDING ALUMINUM


Type PMCO25-16 Sciaky Electric Resistance Welder. Eighty spot welds per minute on two sheets of light alloy of .040" each. Welding capacity: From two thicknesses of .016" each in light alloys up to and including two thicknesses of .091"
3 PHASE A-C SUPPLY LINE
BASIC SCHEMATIC DIAGRAM OF WELDING CIRCUIT SCIAKY INDUCTIVE STORED ENERGY WELDER
MAXIMUM CURRENT RELAY HEAT CONTROL
MAIN SWITCH
CONTACTOR
RECTIFIER
80-170 V. D.C.
WELDING INDUCTOR
WORK

Simplified circuit diagram of the Sciaky Stored Energy System. A three phase a-c supply transformer feeds the rectifier which charges the welding inductor with d-c current. An adjustable maximum current relay initiates the opening of the d-c charging circuit after a predetermined amount of electromagnetic energy has been stored in the inductor.

Electric resistance welding of aluminum and its alloys requires currents of extremely high intensity. (For example, a secondary current of approximately 150,000 amperes is required for spot welding two pieces of 3/16" aluminum alloys.) When a spot weld is made by a conventional A-C SINGLE PHASE Welder, the sudden demand on the supply line unbalances the line and causes a severe voltage drop.

Not only is the resulting "flicker" an annoying nuisance, but the *maximum demand* is boosted to a point where power costs become prohibitive. A battery of such welders requires special, expensive, heavy-duty power lines to handle the peak loads, *if indeed the power is available.*

Utilizing the stored energy principle, the Sciaky Welder has a peak demand of approximately 1/10th that of an a-c machine of comparable capacity. The Sciaky method uses three phase 220 to 550 a-c which is rectified and reduced to 80 to 170 volts d-c. This direct current is stored in the form of electromagnetic energy in a welding inductor during a "charging" period, and then released practically instantaneously as low-voltage, high-amperage welding current. Moreover, a balanced condition is maintained on all three phases of the supply line at near unity power factor.

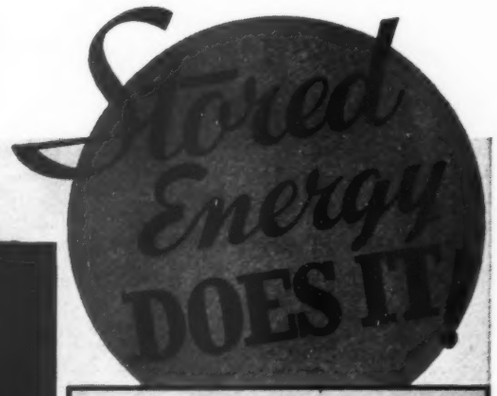
The stored energy principle, the patented variable pressure cycle and an exclusive preheating feature have made the Sciaky Process for aluminum welding preferred by practically every major producer of aircraft in America.

SCIAKY BROS.

Manufacturers of a Complete Line of D-C and A-C Electric Resistance Welding Machines

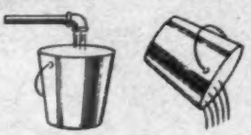
11001 Cottage Grove Avenue, Chicago, Illinois

***Pronounced See-ack-ee**



WHY STORED ENERGY REDUCES POWER COSTS

SCIAKY D-C WELDING REQUIRES *LOW* "MAXIMUM DEMAND"



The analogy of a water pipe and pail illustrates the stored energy principle. The pail is filled from a comparatively small pipe and its entire contents dumped in a fraction of the filling time. This parallels the comparatively slow (actually, a fraction of a second) storage of electromagnetic energy, and its instantaneous release as welding current.

CONVENTIONAL A-C WELDING REQUIRES *HIGH* "MAXIMUM DEMAND"

To continue the analogy, the demands on the power lines by an a-c welder, by comparison, would require a pipe large enough to supply instantly, a volume of water equivalent to the entire contents of the pail. It is this excessive "maximum demand" that runs up the cost for current.

SCIAKY PROCESS ELECTRIC RESISTANCE WELDING
STORED ENERGY · VARIABLE PRESSURE

Puttin' on Paint is old stuff to her!

• With man-power ever dwindling, plane plants everywhere are stepping up their employment of women to help maintain peak production. • When it comes to the painting operation—the gals are in their glory—applying paint is old stuff to them! In other words, they're perfectly adapted to the work. • And so are Valspar Val-Aero Aircraft Finishes! • Modern airplane manufacturing calls for specialized finishes. Finishes that fit right into the production plan, meet the specifications and help the plant deliver the goods! • Manufacturers everywhere are steadily increasing their use of Valspar Val-Aero—the surest sign that these famous finishes are perfectly adapted to the work, too.

VALSPAR

VAL-AERO

A complete line of dependable Aircraft Finishes —that meet government specifications.

Valentine & Company, Inc., 11 East 36th Street, New York, N.Y.
Established 1832 • Makers of the Famous Valspar Finishes

Visual Production Training at Bell

Showing the worker the what and how of his job with a masterfully arranged photographic sequence of operations betters his efficiency, if he is already experienced, and puts him on the production line with confidence and "know-how," if he is new.

By DAVID G. FORMAN

Assistant to the President and Director of Visual Training, Bell Aircraft Corp.

ONE of the most serious problems which the nation's aircraft industry has faced during its two-year period of transition from custom-built manufacture to real quantity production has been the procurement of sufficient trained employees to do the job. Very early it became evident that there weren't enough skilled workers to fill one-tenth the labor requirement.

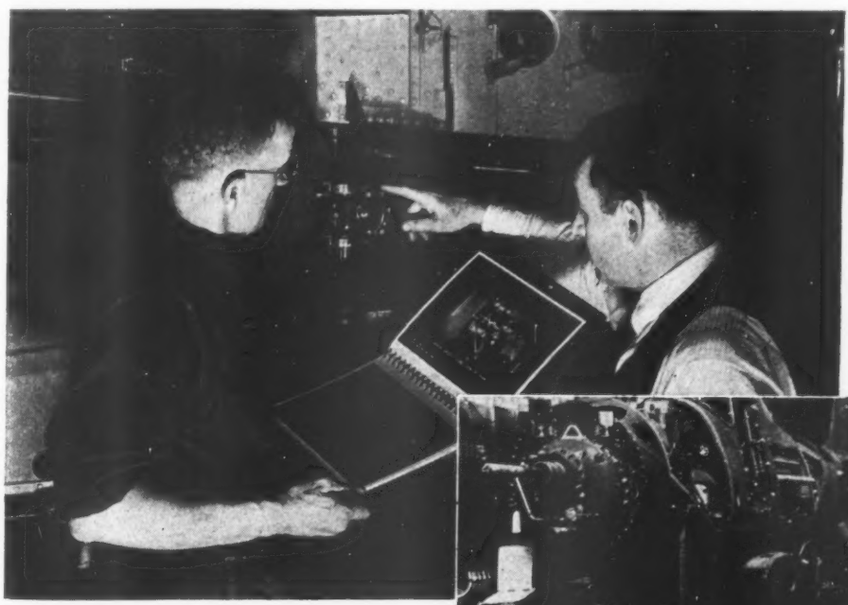
Without exaggerating, the available labor included such unrelated types as: Farmers from the grain fields of Nebraska; full-blooded Indians; boys hardly sprouting whiskers whose hardest previous work had been caddying during vacations; housewives, school teachers and sales clerks, all eager to help win the war, but lacking in training; ex-short order cooks, milk dealers, automobile salesmen, and even a scattering of Bluebook representatives.

Many agencies have given most valuable assistance in providing these completely unskilled labor groups with the basic training necessary. In Buffalo, as elsewhere, the vocational schools have done a splendid job, furnishing thousands of men and women an introduction into the fundamentals of aircraft work through intensive ten-week courses. Other training has been given by NYA courses, and private institutions have aided in this important training work.

At Bell Aircraft, as elsewhere, it was found necessary to do much supplemental training work, and newly inducted "trainees" as paid employees have been given from one to four weeks of instruction, in addition to the courses they received "outside." But even this effort has required amplification, and so Bell Aircraft has initiated another procedure to help build aircraft production workers—visual training.

Training by pictures is of especial value to the aircraft industry because so many operations which have to be performed are difficult even to the employee with previous shop experience. Special materials have to be worked with and precision accessories not com-

★ This is the first of two articles about the visual training program at Bell Aircraft Corporation, and considers the work being done with still pictures. The second, to be published in an early issue, will describe Bell Aircraft's use of specially prepared motion pictures for both production and maintenance training.

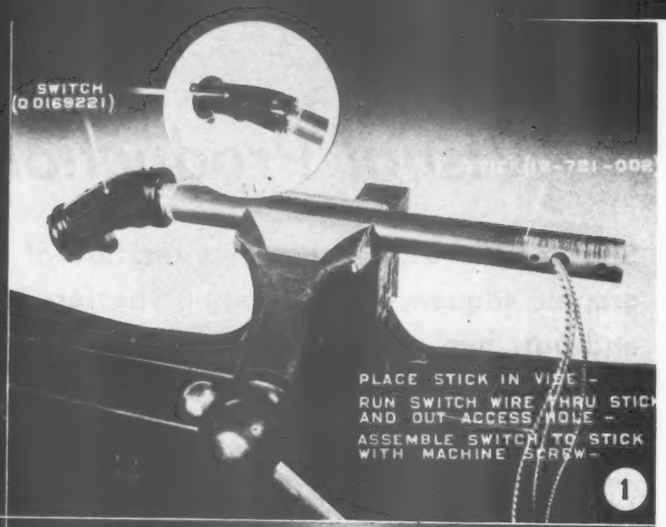


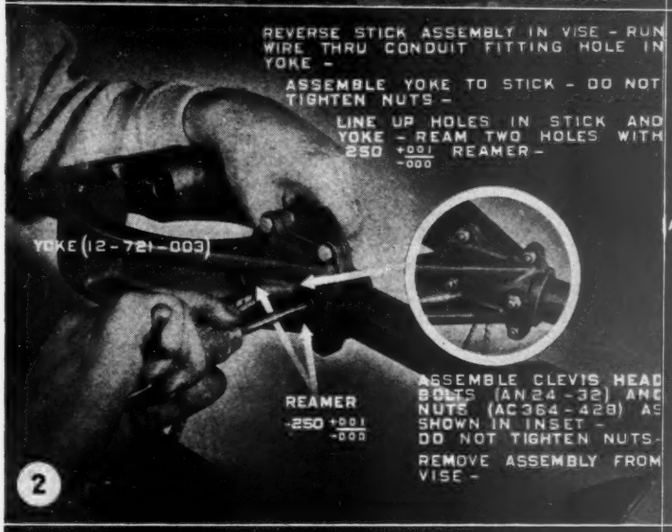
Each set of visual training photographs is bound for use on the assembly lines and at the machines of Bell Aircraft Corp.'s plants. Here one method of using this training material is shown.

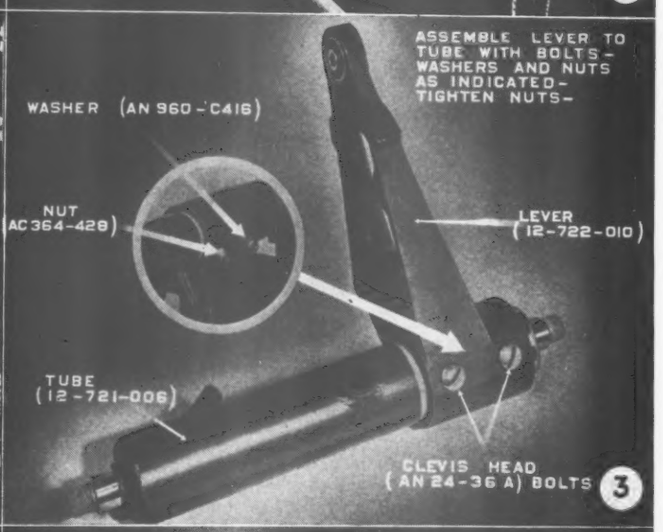
Sets of still pictures with captions, covering specific assembly and fabrication operations, are used for training at Bell Aircraft. Here a leadman, at right, is amplifying photographic instructions for a workman.

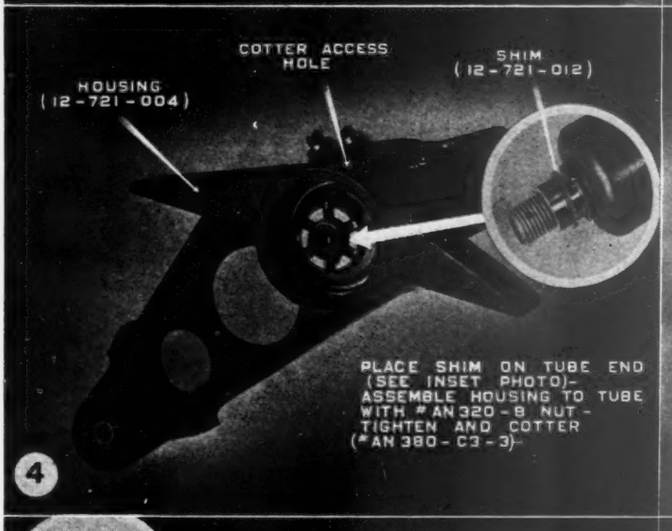
STICK AND YOKE ASSEMBLY

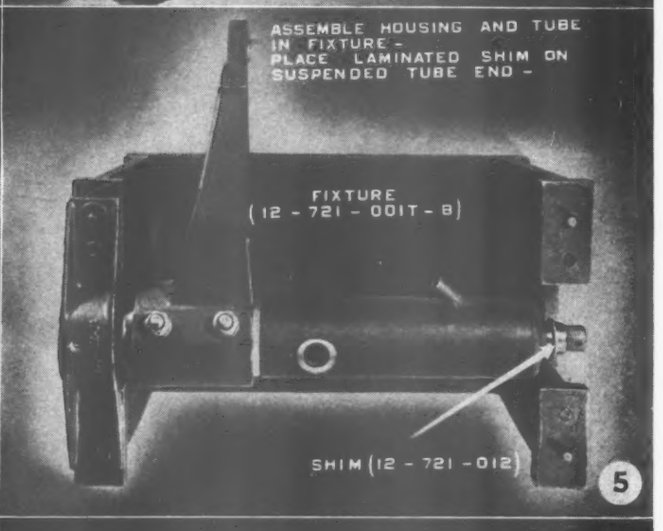
DEPARTMENT 41 PART NO. 12-721-001-1A 10 OPERATIONS

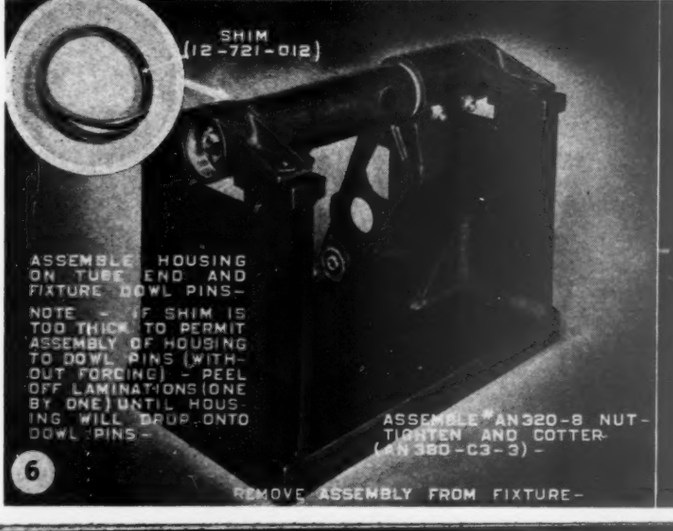

SWITCH (Q 0169221)
PLACE STICK IN VISE -
RUN SWITCH WIRE THRU STICK AND OUT ACCESS HOLE -
ASSEMBLE SWITCH TO STICK WITH MACHINE SCREW -
1

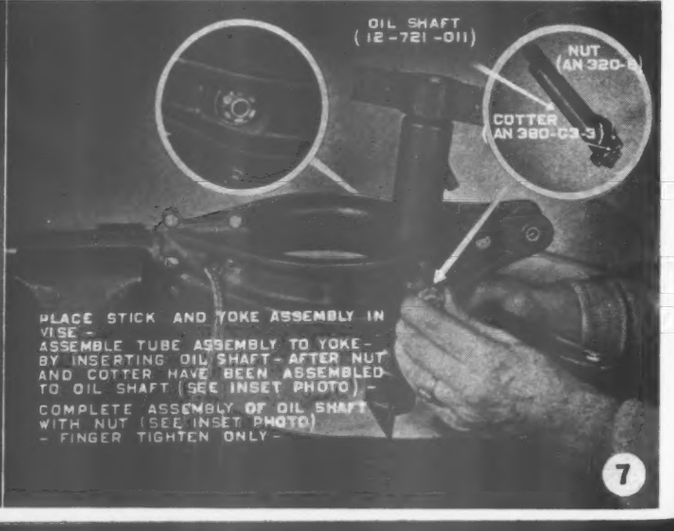

REVERSE STICK ASSEMBLY IN VISE - RUN WIRE THRU CONDUIT FITTING HOLE IN YOKE -
ASSEMBLE YOKE TO STICK - DO NOT TIGHTEN NUTS -
LINE UP HOLES IN STICK AND YOKE - REAM TWO HOLES WITH .250 +.001 -.000 REAMER -
YOKE (12-721-003)
REAMER .250 +.001 -.000
ASSEMBLE CLEVIS HEAD BOLTS (AN 24-32) AND NUTS (AC 364-428) AS SHOWN IN INSET - DO NOT TIGHTEN NUTS -
REMOVE ASSEMBLY FROM VISE -
2


ASSEMBLE LEVER TO TUBE WITH BOLTS - WASHERS AND NUTS AS INDICATED - TIGHTEN NUTS -
WASHER (AN 960-C416)
NUT AC 364-428)
LEVER (12-722-010)
TUBE (12-721-006)
CLEVIS HEAD (AN 24-36 A) BOLTS
3


HOUSING (12-721-004)
COTTER ACCESS HOLE
SHIM (12-721-012)
PLACE SHIM ON TUBE END (SEE INSET PHOTO) - ASSEMBLE HOUSING TO TUBE WITH #AN 320-8 NUT - TIGHTEN AND COTTER (#AN 380-C3-3) -
4




SHIM (12-721-012)
ASSEMBLE HOUSING ON TUBE END AND FIXTURE DOWL PINS -
NOTE - IF SHIM IS TOO THICK TO PERMIT ASSEMBLY OF HOUSING TO DOWL PINS (WITHOUT FORCING) - PEEL OFF LAMINATIONS (ONE BY ONE) UNTIL HOUSING WILL DROP ONTO DOWL PINS -
ASSEMBLE #AN 320-8 NUT - TIGHTEN AND COTTER (AN 380-C3-3) -
REMOVE ASSEMBLY FROM FIXTURE -
6


OIL SHAFT (12-721-011)
NUT (AN 320-8)
COTTER (AN 380-C3-3)
PLACE STICK AND YOKE ASSEMBLY IN VISE -
ASSEMBLE TUBE ASSEMBLY TO YOKE - BY INSERTING OIL SHAFT - AFTER NUT AND COTTER HAVE BEEN ASSEMBLED TO OIL SHAFT (SEE INSET PHOTO) -
COMPLETE ASSEMBLY OF OIL SHAFT WITH NUT (SEE INSET PHOTO) - FINGER TIGHTEN ONLY -
7

ASSEMBLE STOP BOLTS AND LOCK NUTS AS INDICATED-- TIGHTEN LOCK NUTS --
BOLT (12-722-033)
NUT (AN315-3R)
8
ROTATE YOKE 90° IN VISE -
- APPLY PARKER THREAD LUBRICANT TO YOKE END OF FITTING - RUN WIRE THRU FITTING AND SPECIAL CONDUIT WRENCH -
ASSEMBLE FITTING TO YOKE WITH WRENCH - TIGHT FIT -
CONDUIT WRENCH (TA-31380)
CONDUIT FITTING (15-721-033)
9
ASSEMBLE LINE ROD TO YOKE WITH #AN25-29 CLEVIS HEAD BOLT #AN320-5 NUT - TIGHTEN AND COTTER #AN380-C2-3-
TIGHTEN ELASTIC STOP NUTS AS INDICATED BY ARROWS
TIGHTEN NUT ON OIL SHAFT AND COTTER #AN380-C3-3
LINE ROD (12-723-001)
10
ASSEMBLE LINE ROD TO LEVER WITH #AN24-18 BOLT AND #AN320-4 NUT - TIGHTEN AND COTTER #AN380-C2-3 -
LINE ROD
11
ASSEMBLE BOND BRAID TO YOKE WITH SELF TAPPING SCREW (SEE INSET PHOTO) -
BOND BRAID (5581-14)
SCREW (10290-6-8)
WASHER (AC936-86)
SCRAPE OFF PAINT AROUND SCREW HOLE BEFORE ASSEMBLY -
12
RUN WIRE THRU FLEX TUBE - -(SEE INSET PHOTO) - ASSEMBLE FLEX TUBE TO CONDUIT FITTING -
INSERT WRENCH POSITIONING PIN IN YOKE END OF STICK - SNUG FIT -
TIGHTEN FLEX TUBE LOCKING NUT WITH WRENCH -
13

This set of pictures visualizes the assembly of the control stick and yoke for an Army P-39 "Airacobra". Such sets are used on the assembly line at Bell to instruct both new and old workers. The inserts serve to clarify certain details of the assembly for the worker.

monly used by industry are required.

As a result of this set of conditions, the worker needs more than the basic training which he obtains in a vocational school, or afterwards in the plant. For example, the operations necessary to install the Plexiglas cabin enclosure of an Army P-39 *Airacobra* present many problems to the uninitiated aircraft worker. The material itself is new to most workmen, and must be handled by special methods. Several operations are involved in the installation, and they must be performed in the proper order.

It is possible, of course, to write a minutely detailed set of instructions concerning a single operation. These instructions may even be so specific as to tell the worker how to hold his right and left hands while performing every phase of the operation. But, unfortunately, even instruction sheets so pre-

(*Turn to page* 314)

Adapting Labor to The Aviation Industry

Here is an answer to one of the most trying problems of the mass-producing aviation industry. The manufacture of precision parts for aircraft engines in quantity would seem to call for tapping an already nearly dry well of skilled labor. The N. A. Woodworth Co. is taking on the butcher, baker, and housewife with an intelligent program for putting their talents to work.

By CHESTER S. RICKER

"THIS COUNTRY'S production program can be visibly affected unless we place new labor where it will have the opportunity for gradual orientation and work happily and enthusiastically. That, in a word, is the cardinal function of both our factory management and employment offices today." Thus speaks N. A. Woodworth of the company bearing his name whose rapidly growing production of aircraft engine parts is based on a farsighted policy of building a productive organization out of raw labor material.

An armed force of over five million men needs fifty million workers to support it. With more and more men being called into service, every manufacturer is confronted with the problem of getting an adequate supply of labor to turn out the needed parts for the war machine.

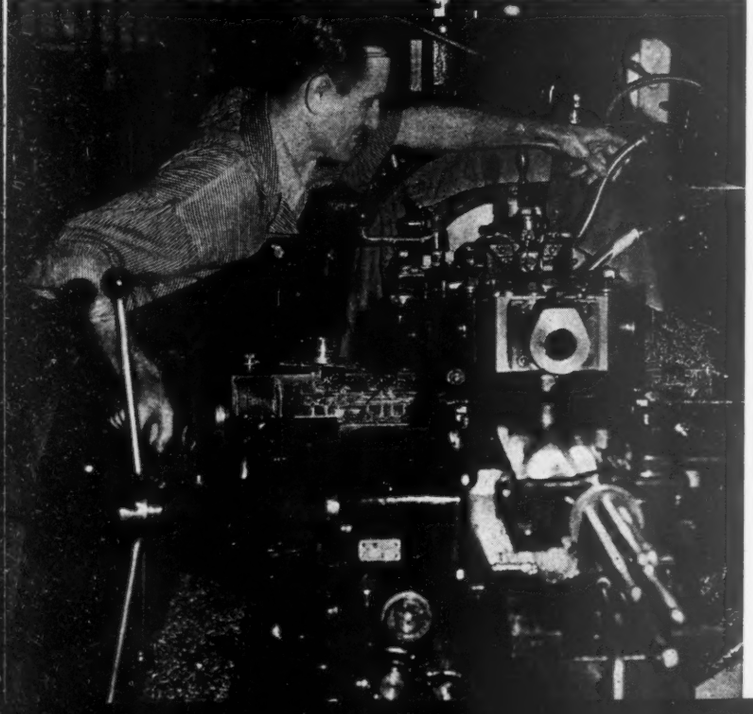
The advent of war brought Mr. Woodworth back into the production harness after retiring as president of the Ex-Cell-O Corporation, of which he was founder. He came back with a lot of ideas on how to get the greatest productive effort out of the labor material at hand.

He has refused to pirate trained personnel from other plants. To protect his production rate, he has now less than four percent of his force with 1-A selective service rating. He has developed such a family spirit in the organization that practically all labor recruited is by employees who are on the job. Relatives are no barrier to employment of men as long as they are not those of some foreman or executive, but no women are employed who have relatives working in the plant. Out of this idea has come the arrangement of shifts so that neighbors can come to work together and conserve their cars and tires.

Any time a manufacturer tries to increase production in a rapidly expanding factory that is running 24 hr. a day 7 days a week, the employment office has its hands full as well as the shop management.

The key man of the Woodworth plant is E. W. LaMonte, factory manager with 30 yr. experience in handling labor. He is assisted by B. E. Larson, who has had 20 yr. personnel experience. Larson handles, on an average, 300 applicants a day. Of these about half do not have any factory experience and nearly half are women. About 36 percent of the women applicants are put on the job. Larson tries to put them on jobs for which they are most suited. Some of the green labor is made up of school teachers, stenographers, waitresses, housewives and housemaids. Auto salesmen, lawyers, jewelers, linotype operators, hotel chefs and stewards, plumbers and watchmakers were among the male applicants. No psychological or I.Q. tests are made of the applicants. Instead, Larson "doodles" on an application card as he interviews each one. Simple symbols indicate what he thinks about the applicant such as: VGHT (very good for heat treat department); CGW (college graduate, willing); TK (the kind we want); or WC (will call when job is open). When the employee

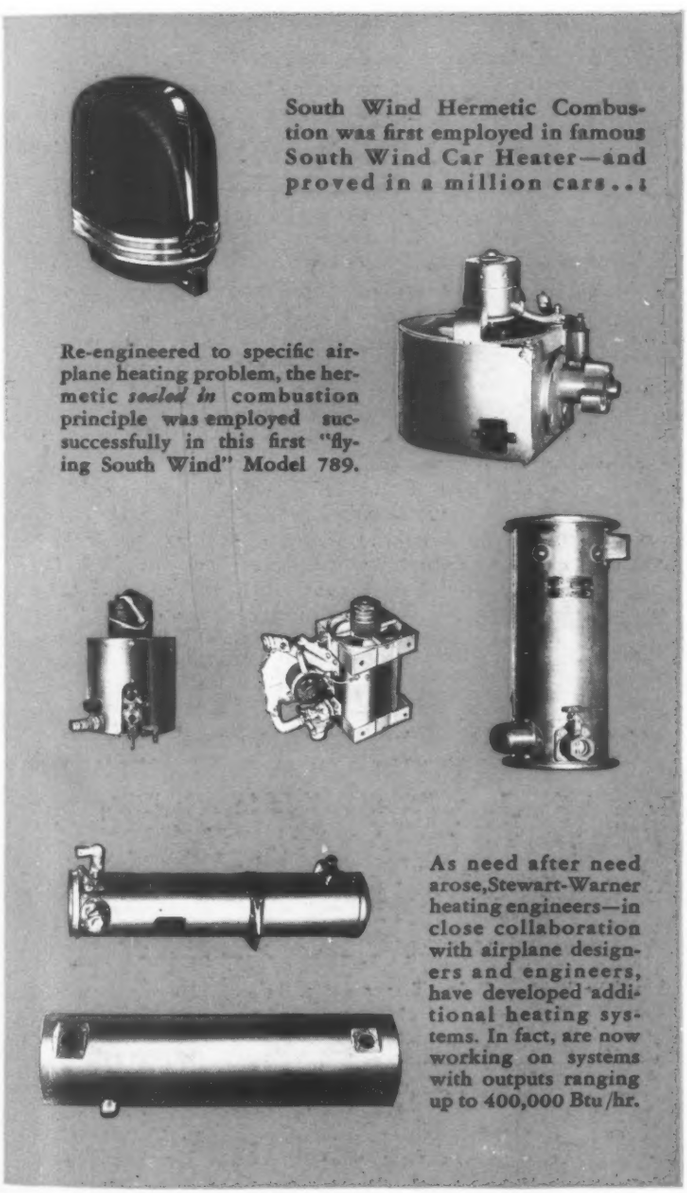
RIGHT: Paul Zogas was a chef in a Detroit restaurant and understands the value of heat control. He is now a good tool hardener in the heat treat and plating division of the Woodworth company. LEFT: Doyle Hill was an easy convert from linotype operator to screw machine operator.



NEW HIGH-OUTPUT HEATERS

Designed to Meet Aviation's Need!

Midget Lightweight Units Fit Available Space—
Give the Heat You Want . . . Where You Want It



South Wind Hermetic Combustion was first employed in famous South Wind Car Heater—and proved in a million cars . . .

Re-engineered to specific airplane heating problem, the hermetic *sealed in* combustion principle was employed successfully in this first "flying South Wind" Model 789.

As need after need arose, Stewart-Warner heating engineers—in close collaboration with airplane designers and engineers, have developed additional heating systems. In fact, are now working on systems with outputs ranging up to 400,000 Btu/hr.

Today's high-altitude fighting demanded them! Heaters weighing less—taking less room—giving far more heat—operating at altitudes where an open flame dies for lack of air! A dependable sort of heat, delivering heat wherever wanted, in controllable volume and at maximum capacity per pound of weight! And our soldiers of the air needed them *fast!*

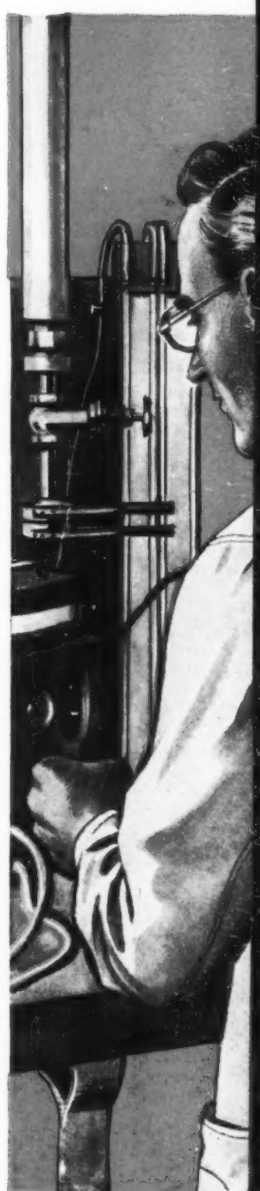
The possible solution? Stewart-Warner heating specialists visioned it in a radically *new application* of a development—itself hailed as radical—which they had proved in a million cars . . . the "hermetic combustion" principle of the famous South Wind car heater.

Working hand in hand with the aviation industry, Stewart-Warner engineers inaugurated a constant program of development—accelerated as each new need arose—and continuing today at an ever increasing pace.

With experience unparalleled in this specialized field—with engineering and research facilities unmatched by others—they have already supplied almost every American manufacturer of bombers and fighters with heaters developed specifically for individual jobs. From the first small spot heater with 8,500 Btu/hr. output and weight of 8½ pounds, models are being produced with capacities as great as 160,000 Btu/hr., together with a whole range of needed accessories, for connection to airplane engines or for independent operations.

Yet advanced as those first heaters seemed only months ago, they are already outmoded in comparison with current developments—such things as a complete heater requiring no outside power, weighing only 15 pounds, delivering upwards of 200,000 Btu/hr. More than 10,000 Btu/hr. per pound! Or wing anti-icers of both exhaust and combustion types! Or many others nearing announcement.

South Wind
REG. U. S. PAT. OFF.
Hermetic Combustion
Heaters

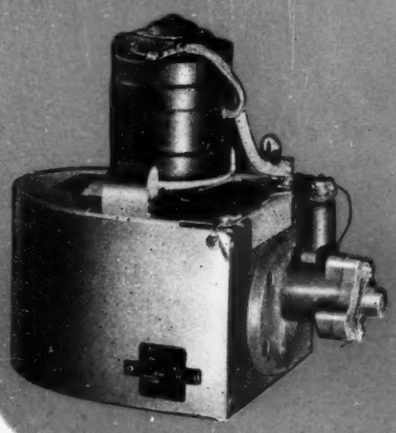


Stewart-Warner Aircraft Heating Equipment has been specified for use on one or more models of all of the following Companies:

Bell Aircraft	Consolidated	Fairchild	Lockheed	Vega
Boeing	Curtiss-Wright	Fleetwings	North American	Vought-Sikorsky
Brewster	Douglas	Grumman	Northrop	Vultee

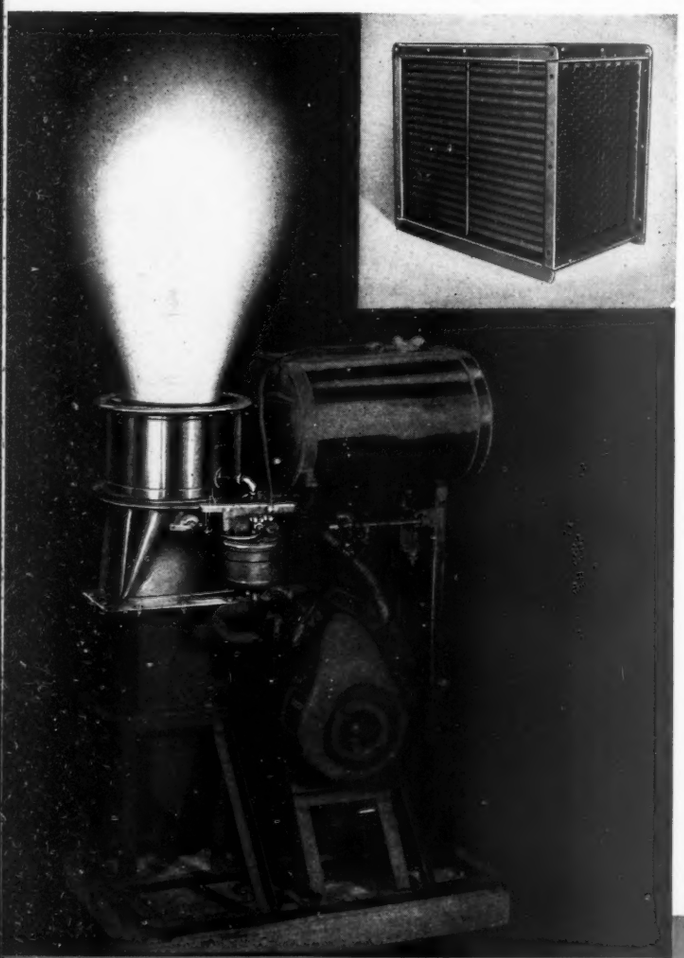
NEED SPOT HEAT?

FOR PERSONNEL? GUNS? INSTRUMENTS?



This 8,500 Btu/hr. South Wind has virtually unlimited adaptability where moderate heat supply is needed for planes and ground use.

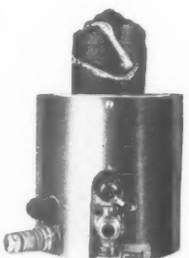
• In more than 20 different variations of shroud, mounting, and voltage, this versatile South Wind model is serving a variety of uses where heating problems require concentrated delivery of up to 8,500 Btu/hr. It may be engine-connected or is adaptable for electric or hydraulic drive or with gas-engine unit. While widely used as a spot heater for instruments, guns and personnel—it also provides efficient space heating for small enclosures, or for larger spaces by means of multiple units. A practical method of operating multiple units is diagrammed below.

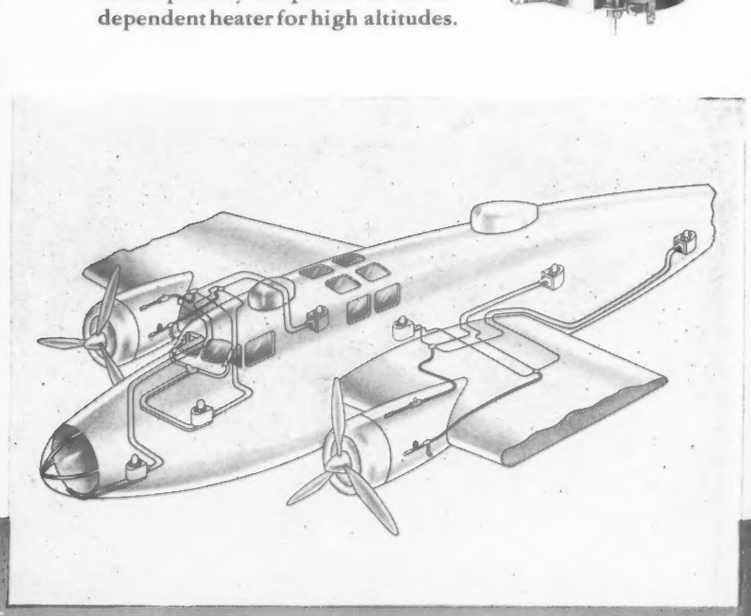


Stewart-Warner's experience in building heaters which burn gasoline has lead to tremendous development in heat exchangers for exhaust gas. Experimental test facilities permit simulation of engine exhaust all the way up to 3,000,000 Btu/hr.

Coming!

Constantly improved versions like that pictured at right! No heavier than the heater above, this newer model delivers 10,000 Btu/hr. and materially reduces power consumption. Specially adaptable as an independent heater for high altitudes.

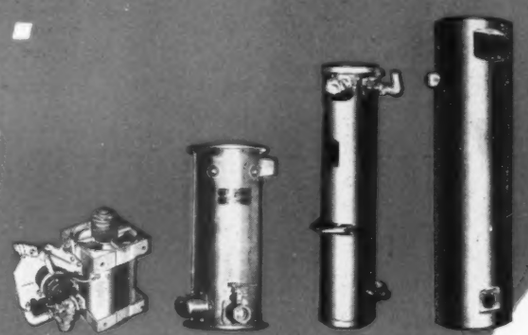




South Wind Heaters

REG. U. S. PAT. OFF.

WHERE ABUNDANT HEAT OUTPUT IS REQUIRED *and Physical Limits Must Be Met...*



As new heating problems brought demands for larger volume of heat, the hermetic combustion principle was applied in larger and larger units. Four typical units shown produce 20,000—40,000—80,000—160,000 Btu /hr.

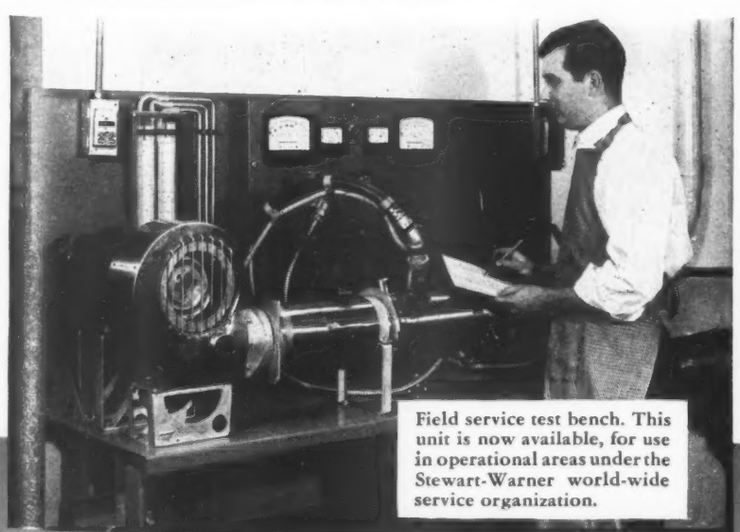
● Two small cylinders, only 7 1/16" x 15 7/16" hidden in the wheel-wells, heat Stratoliners at 50° below zero! A 15-pound furnace a child can lift gives heat enough for a 10-room house in Minnesota! A stone-cold heater puts out 200,000 Btu /hr. . . . 9 seconds later!

When heat is vital, heater space restricted to scant inches, and each pound saved makes way for a precious extra pound of fuel or ammunition . . . Time after time, the South Wind "hermetic combustion" principle has offered a way out.

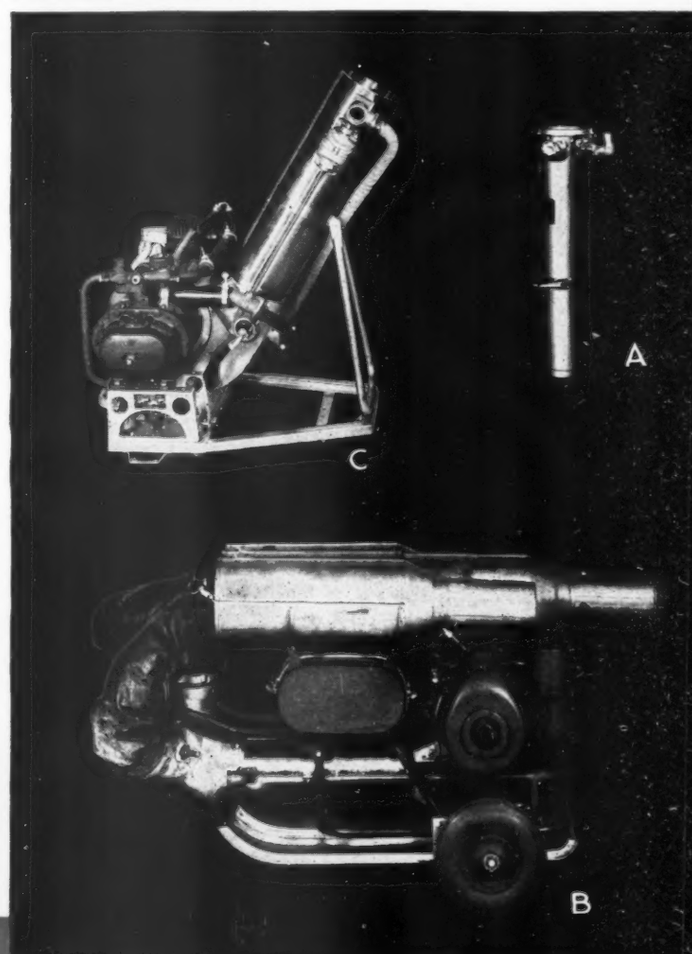
As needs multiplied, heaters of 20,000—40,000—80,000—160,000 Btu /hr. and more were developed. Both pre-set and manual-set automatic controls were made available. New fuel-air mixture sources were worked out as new operating conditions were encountered. A wide variety of shrouds, mountings, blowers, pumps, etc., was developed as special requirements arose. Each job brought new problems—each brought ideas for *better and better use* of the basic principle.

Constant Improvement

Unceasing research and development—coupled with extensive operational experience in the field—is stepping up South Wind performance week after week! In production now are the latest remarkably improved South Wind models. And now, too, with this unequalled background of research and knowledge, we are undertaking new tasks—such as the development of a new heating system which gives promise of an output up to 2,400,000 Btu /hr.



Field service test bench. This unit is now available, for use in operational areas under the Stewart-Warner world-wide service organization.

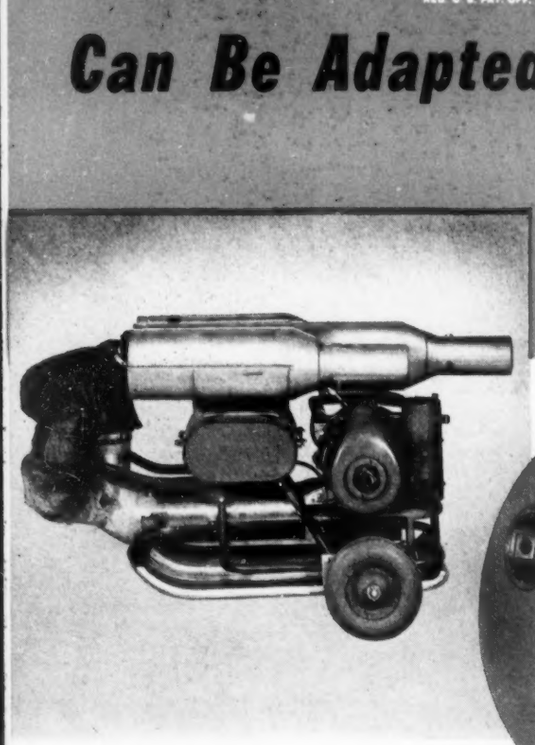


How basic units are engineered to each specific use. The 80,000 Btu /hr. unit above (**A**)—plus fuel tank, gasoline-powered blower and chassis with retractable wheels and toboggan base—becomes a complete portable unit for ground use. (**B**) With gas-powered blower and manual-set, automatically-operating heat control, (**C**) it provides an effective unit used for aircraft cabin heating aloft.

South Wind Heaters

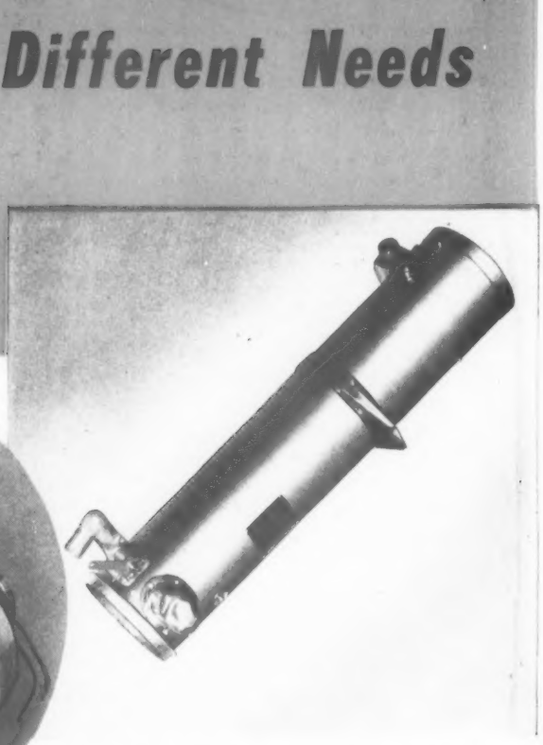
REG. U. S. PAT. OFF.

How "South Wind Hermetic Combustion" Can Be Adapted to Widely Different Needs

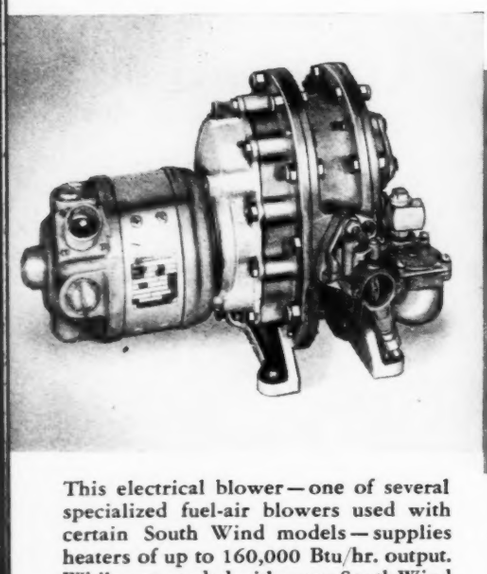


For starting cold engines—de-greasing new ones—liquefying heavy lubricants—heating cabins of planes on the ground, tents and shelters—outdoor construction work and many similar uses—this portable South Wind with flexible collapsible ducts up to 23 feet long is ideal.

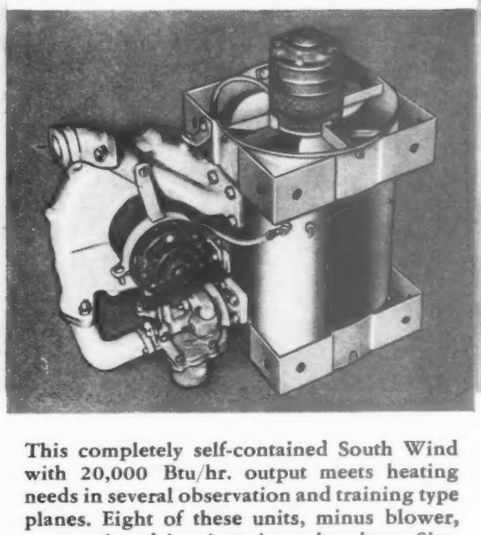
In some transport planes, 2 of these 80,000 Btu/hr. South Winds, engine-connected, are mounted at the top of the cabin for cabin heating. ➡



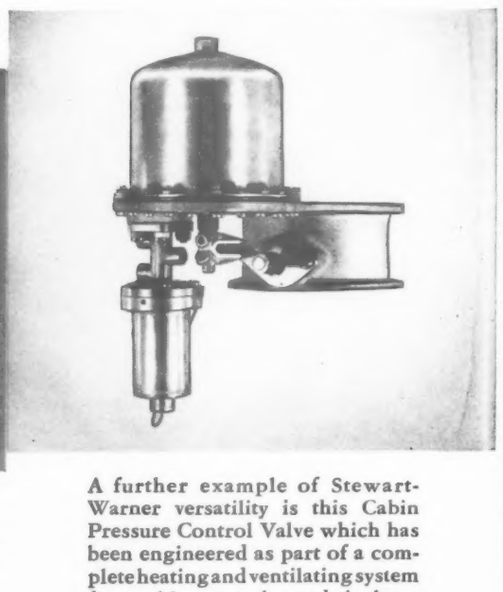
← This heater is a completely self-contained, electrically operated heater, of high output. It has been designed to meet substantial requirements for a very large volume of ventilating air, as well as high heat capacity. It actually delivers 160,000 BTU per hour at sea level, while delivering 54 pounds per minute of air against a restriction of 2" of water; yet its weight is only 111 pounds.



This electrical blower—one of several specialized fuel-air blowers used with certain South Wind models—supplies heaters of up to 160,000 Btu/hr. output. While not needed with many South Wind models, it may have application on some other problem you face.



This completely self-contained South Wind with 20,000 Btu/hr. output meets heating needs in several observation and training type planes. Eight of these units, minus blower, are employed in giant Army bombers. Similar units are used in various Army trailers.



A further example of Stewart-Warner versatility is this Cabin Pressure Control Valve which has been engineered as part of a complete heating and ventilating system for a cabin super charged airplane.

Another Product of

STEWART WARNER

South Wind REG. U. S. PAT. OFF. HERMETIC COMBUSTION Heaters

is called a more complete card is made out.

Precision production is required on all the aircraft parts produced in this plant, yet no apprentice school is required. Woodworth precision training is carried out right on the job itself. Seventy percent of the employees in the plant today started green. They are taught either by the former operator on that machine or a special work leader who can guide several new operators at a time. Teaching often is the first step in the "upgrading" of employees. There are today, 214 possible ways of upgrading in the plant. Through this system come all the supervisors and foremen in the plant, practically 100 percent today. Nearly all of them were unskilled or semi-skilled when first employed.

LaMonte claims that the production per square foot of factory space with green labor is unusually high because of four important factors: the method of recruiting labor; the way workers are trained; their compensation and the incentive of upgrading.

Women who were "green hands" a short time ago work out well on precision jobs such as high speed boring operations where the operator must be alert for tool failure, quality of finish, and correct amount of stock removal.

The excellence of women in inspection work is an established fact. Here, Betty Taylor operates a delicate mechanism to test the hardness of steel.

E. W. LaMonte, factory manager, and B. E. Larson, employment manager, are in charge of the "human conversion" program. They are constantly engaged in developing and upgrading unskilled workers to do the vital jobs in the important work of producing aircraft engine parts.

Women are playing an increasingly important part in production. At the present time the ratio is about 40 percent women, but this is increasing. Most women are not shop conscious and so take some time to orient themselves. However, the method of teaching green operators and the guidance of a shop matron who is also a trained nurse helps them to become adjusted. Women are also given two 15 min. rest periods each day. At the present time women are used as grinders, polishing operators, drill press and other light machine operators. Women work on day or night shifts just as the men.

(*Turn to page* 300)

Wide World Photo

In some sections of the country, especially in the southern California area, multiple shift operation has speeded output without waiting for plant expansion. Note the easily movable floodlights which help transform a storage space into a production line.

SURVEY OF MULTIPLE SHIFT

"Aviation's" survey shows majority of industry conducting efficient round-the-clock operations. Floor space expansion leveling off, but ample facilities for increased production available through addition of manpower.

By JOHN FOSTER, JR.

THE AIRCRAFT MANUFACTURING industry has reached a plateau in physical expansion of plant facilities and from now on our efforts will be directed toward a more intensive use of our productive floor space.

This does not mean that our brick and mortar expansion is necessarily at an end as there are a number of new projects in the offing. But the floor space curve is flattening and it is proper that we should pause during a part of 1942 to consolidate our gains.

This consolidation will take place just as soon as the problems of transportation and material shortages are solved. And it will take the form of a substantial increase in direct labor force for multiple shift operation.

It will neither comfort nor aid the Axis to know that much of the industry has been able to expand to round-the-clock operation with no loss of efficiency and that all the industry is ready, willing and more-than-able to further boost output through addition of manpower.*

A survey just completed by AVIATION —in which replies were received from manufacturers producing more than 75 percent of the nation's aircraft— shows conclusively that multiple shift operations thus far have presented no insurmountable problems to the industry and, that with experience already gained, such operations will prove no barrier to vastly increased output.

The survey reveals many definite patterns in multiple shift operations, and the close approach of the industry as a whole to selected companies with outstanding production records indicates that it is rapidly approaching the best possible methods. Among the major points clearly outlined are these:

Although the majority of employees work days, the industry has built up a backlog of multiple shift experience which will permit greatly increased output without the necessity of vast plant expansion, a factor of great importance in view of recent reports that maximum production is being sought with existing facilities rather than through projected additions to present plant structures.

Three shifts of approximately the same number of hours appear to be the answer to optimum production.

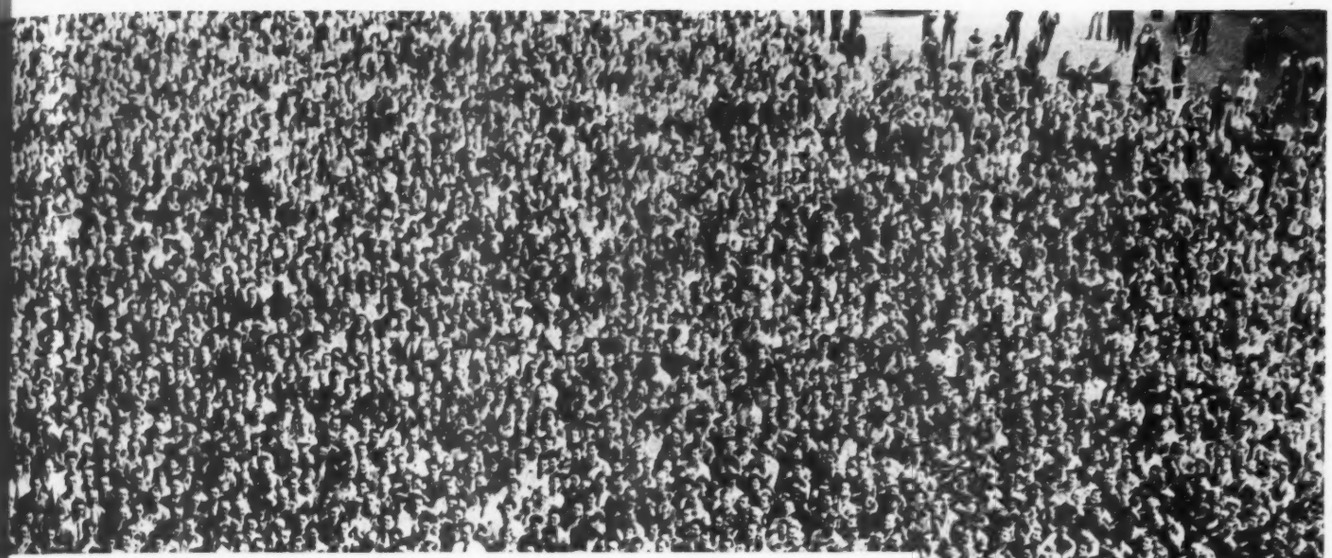
The aircraft industry's night workers can be counted on not only to get to work on time and as regularly as day workers, but to produce as much man-for-man and hour-for-hour because, on the whole, they are as reliable and just about as skilled. The night workers' accident rate compares favorably with that of the day workers' and their general health and tractability are on a par.

About the only operating cost increases inherent to multiple shift operations are caused by wage premiums common to night work.

Companies planning greatly expanded multiple shift operations must consider —as many have already—both transportation and housing facilities, for both today can easily affect punctuality and absenteeism of both day and night workers.

Replies to the survey questionnaire indicate that practically all of America's aircraft, including training as well as combat planes, are rolling from assembly lines in three shifts. The extremely low percentage coming from two-shift lines represent mainly companies now in transition from two to three shifts, organizations limited in special equipment and, in one case, where housing conditions make three-shift operations impracticable.

* As late as 1939 much of the German aircraft industry was operating on a one 8-h. shift basis.—Ed.



Traffic beyond plant gates may affect round-the-clock operations, and some manufacturers already are working to eliminate transportation bottlenecks.

OPERATIONS . . .

How much the industry can increase production through added personnel is shown by the proportion of employees per shift. In companies operating three shifts, an average of 52 percent of all employees are first, or day shift workers, with 35.6 percent working the second, or swing shift, and the remaining 12.4 percent on the third, or graveyard shift. This ratio closely approximates that of selected companies with outstanding production records, an indication it has thus far proved the most efficient. The overall average compares with these organizations as follows: first shift, 1 percent less; second, 2.1 percent less and; third, 3.3 percent more.

The range of employees on the day shift ran from slightly under 48 percent of the total up to 80 percent; those on the second ranged from 29 to a little more than 42 percent and the third embraced from 0.8 up to 21 percent of the total.

Of those companies operating two shifts, the average ratio was 69.5 percent for the first and 30.5 for the second, with respective ranges of from 60 to 80 percent of the total on the first and an even 20 to 40 percent on the second.

In no case, however, was efficiency of the second or third shifts reported to be materially lower than that of the first, such as has been found in other industries, nor does production of the night aircraft worker tend to decline, as it does in some other industries. There were, in fact, several instances reported in which second and third shift workers showed greater efficiency as measured by production than did the day workers. In one outstanding case the production rate of the graveyard workers was almost twice that of the day employees who trailed even the second shift on a man-to-man basis by some 14 percent. Since no studies have been made to determine the cause, it must stand as an exception, for on the whole the proportion of production per shift was in direct ratio to the number of employees.

Few companies reported any marked difference in skill among the various shifts, the little noted being attributed to the fact that the men were new employees. It was not considered sufficient to materially affect production. Any marked, sudden increase of the night shifts, however, would undoubtedly require some shuffling of supervisors and leaders or careful indoctrination of new workers to prevent a dislocation of the production ratio. In some cases, of course, choice of men having seniority has thrown the newer and less skilled men on the second and third shifts despite the premium paid night workers.

Such premiums constitute almost the only difference in operating costs for multiple shift operations, since every reply stated that no special equipment other than lights had been found necessary.

The matter of night work premiums has been handled in several different ways including, in addition to higher hourly pay rates, time bonuses and eight hours' pay for shorter shifts.

Majority of the industry, the replies showed, has been paying a straight 5 cents per hour more for the second shift, with others paying premiums ranging from 4 to 10 cents, and still others paying cash bonuses based on over-all earnings. The average second shift premium of those reporting higher hourly rates was 5.5 cents per hour. Since that figure is only 0.3 cents below the average of the selected companies noted earlier, this method appears to have been the most satisfactory to both management and labor.

(*Turn to page* 321)

8 out of 10

OUT of 2,385 commercial flights to and from Boston Municipal Airport during September 1941 — 1,930 flights (81%) had Cuno Filters installed.

Why Do Engine and Aircraft Builders Concur on Cuno for Fluid Protection?

Longer flights and larger planes . . . efforts to reduce maintenance problems . . . and the desire to safeguard every factor for high-speed and high-altitude flying . . . have led to the widespread adoption of Cuno Filters.

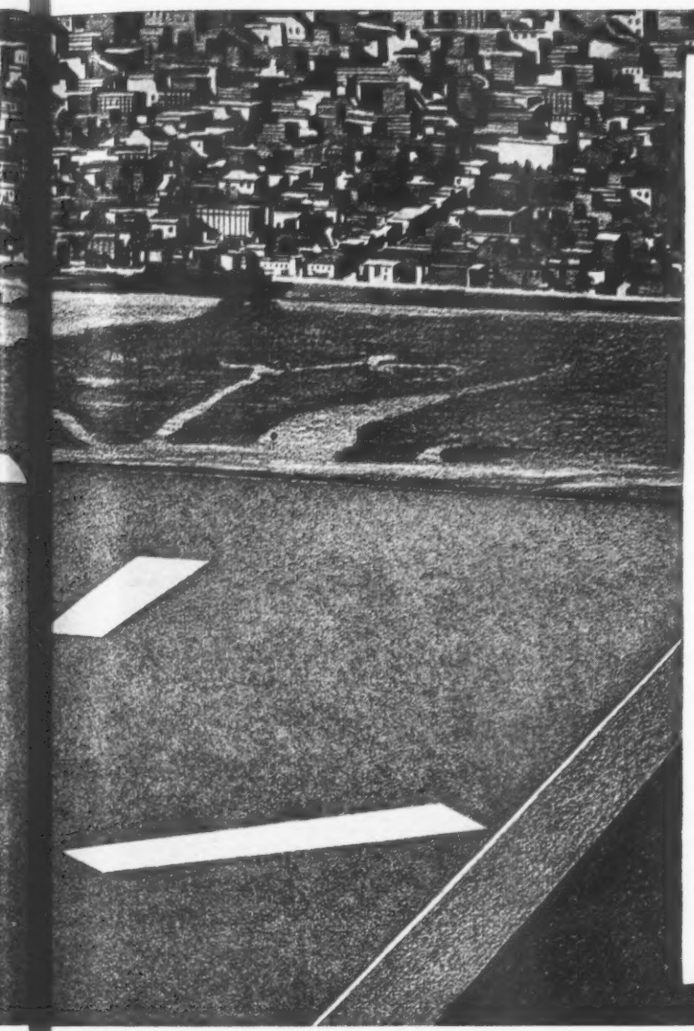
Cuno Pioneering

Cuno engineers pioneered in fluid-cleaning on aircraft services. Originally it was the continuously-cleanable feature of the Cuno Auto-Klean that attracted the industry's attention years ago. Experience proved the Cuno Filter completely dependable, a trouble-free safeguard maintaining efficiency on full flow throughout existence of the installation. Later, a hydraulic motor was developed to make the filter completely automatic.

More recently, other fluid-handling problems . . . hydraulic controls, glycol cabin heating, etc. . . . have been solved with the help of Cuno engineering — with still further developments for the future now in progress.

Cuno Field Service

Meanwhile, Cuno's service to the industry has become increasingly valuable. On top of creative engineering on the filter and aid to aircraft designers (especially on built-in applications), our field service follows the installations through *operation*. We assume the responsibility of familiarizing aircraft *maintenance* men with this fluid-cleaning method.



★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

In this space, Cuno, conforming to the practice of previous ads, had intended publishing a map and certain information regarding the location, identification and facilities of this airport. In the interest of withholding information which might be construed as valuable in a military sense, we have removed the map and text from this panel.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

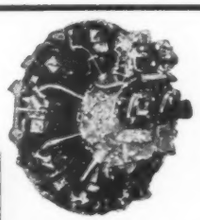
have CUNO FILTRATION

When, in your work, you think of fluids, think of Cuno — the company that safeguards the fluids that safeguard flight.

KEEP FLOW ON "GO" WITH

CUNO

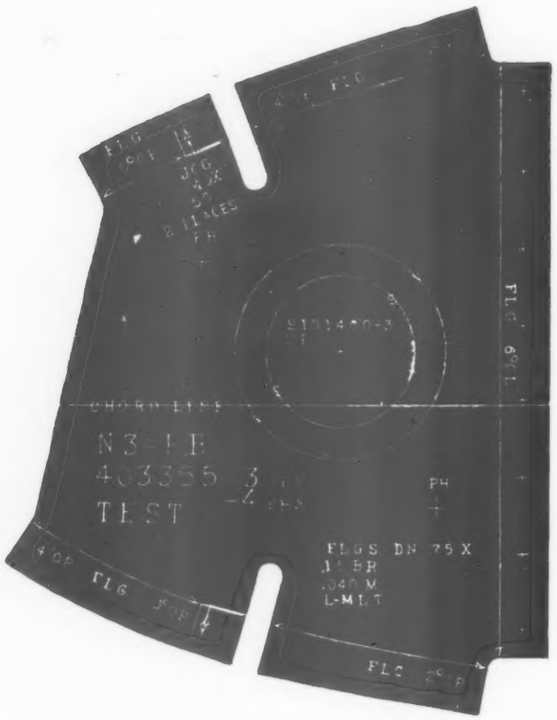
THE "FILTER-FINE" STRAINER



American Airlines, eager to improve maintenance, appreciates Cuno efficiency

The compact Cuno Filter built into the Wright Cyclone engines of American's Flagship Fleet does not require periodic replacement. The cleaner blades, extending into each slot of the rotating element, *comb* out imbedded solids — thoroughly restoring the free area, not just scraping off the surface. This is vital on lubrication services — there's no sludge accumulation *inside* the filter element, no danger of the filter collapsing, with station service reduced to a minimum.

Cuno Engineering Corporation, 708 South Vine St., Meriden, Conn.



LEFT: This original layout templet including the form-block and the router-block lines is being reproduced by the electrolytic etching process. RIGHT: The layout templet as produced completely by the process. Its contour is well within 0.005 in. tolerance and the scribed lines and stenciling have been transferred with practically perfect register.

Electro-etching For Templet Duplication

One of the key factors in the mass production of airplanes is engineering-lofting technique. Any improvements inevitably mean greater production in less time. This new method of duplicating templets by etching is, therefore, a significant development.

By F. M. GIBIAN and WES CHATTEN
Northrop Aircraft Inc.

DURING AN EXHAUSTIVE STUDY to determine the best engineering-loft procedure, Northrop Aircraft, Inc., narrowed the question of templet duplication down to finding a process that would give maximum duplication accuracy with the greatest economy in terms of man-hours and elapsed time.

Certain major points concerning any duplication process had to be considered in order to arrive at an answer. First, exact scale reproduction was to be assured; distortions or widened lines due to optical or contact error could not be tolerated. The duplication had to be extremely durable, more so than the scribed original, if possible. The complete templet had to be produced to avoid costly cutting operations. The process had to be accomplished with semi-skilled labor, with the minimum of installation and operating cost.

The photographic principle of shop templet duplication could not produce results that would measure up to these standards in their entirety. Lenses of sufficient focal length to cover large surfaces and maintain sharpness of line are difficult and costly to grind without distortion or aberration of some sort. The resulting photographic image laminated on metal lacks durability, an important item under present shop conditions where tool durability means time and money saved. Variations in templet stock thickness, and the necessity for keeping copy and lens boards in absolute parallel to the sensitized metal have presented some extremely difficult problems.

The X-ray method of duplication removes some of the undesirable points of photography. Since it is a direct contact method, absolute accuracy is maintained. However, the image is not dur-

In This Electrical War Front Lines are WIRE LINES

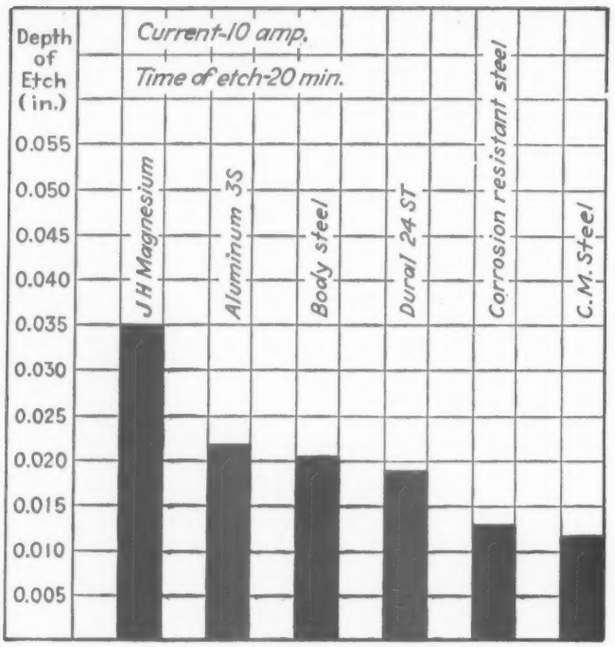
War has "gone electrical." Every plane that flies—every tank and transport—every ship and sub—all are moved or controlled or directed by wire.

Lines of wire play a giant role on every front. And highly specialized wires of a thousand different types are needed for a thousand different crucial applications.

Because of their long and close cooperation with the Aviation, Automotive, Radio, and other industries . . . because of their 40 years of experience building plus performance values into wire . . . Belden research and production engineers were ready for our emergency. Belden Wire is FRONT LINE Materiel.

Belden Manufacturing Company
4665 W. Van Buren St., Chicago, Ill.

Belden WIRE



LEFT: Chrome-molybdenum punches for Kirksite blank and pierce dies such as the one shown here, can be made by the Northrop electrolytic etching process. RIGHT: This chart shows the depth of etch on various materials after 20 min. in the electrolytic bath.

able enough for ordinary rough shop usage. Both the X-ray and photographic systems require hand cutting and filing. Neither method is economical in terms of equipment nor operating expense.

To overcome the objections to the photographic method, and to meet the standards desired, Northrop developed the electrolytic etching method described in this article for duplicating shop templets.

Making the Negative

As in practically all duplicating processes the first step is to obtain a negative. It is secured by a contact printing method. The templet or group of templets to be duplicated is first placed on the bed of a specially designed press which resembles in principle the cylinder printing press. It consists of a heavy horizontal bed upon which is mounted a heavy steel roller made to travel mechanically back and forth across the face of the bed. The roller is spring loaded against the bed of the machines to compensate for slight variations in metal thickness. The press can be any size depending upon the size stock one wants to use; 4x6 ft. makes a convenient size from the standpoint of handling.

The face of the templet is inked by means of a composition roller and a special ink which was formulated for our purpose by a leading manufacturer of printers inks. It has excellent laying qualities and maximum opacity. A sheet of thin grained acetate is placed over the templet and a total pressure of approximately 1,000 lb. is applied by passing the steel roller over it.

Due to the fact that the ink does not fill the scribed lines or stamp depressions on the templets, these areas are clear on the resulting impression on the acetate sheet. It is dusted with finely ground lamp black in order to insure instantaneous drying of the ink image and to increase its opacity. This is the negative.

The duplicate templets are made from automobile body steel. It must be rendered chemically clean before any work can begin. It is put through an ordinary degreasing process, using any type of greaseless solvent such as carbon-tetrachloride or phenoid. The steel is then scrubbed with a stiff brush and powdered pumice. This operation may be done mechanically or by hand, depending upon the volume of work. All traces of pumice are thoroughly flushed away with cold tap water.

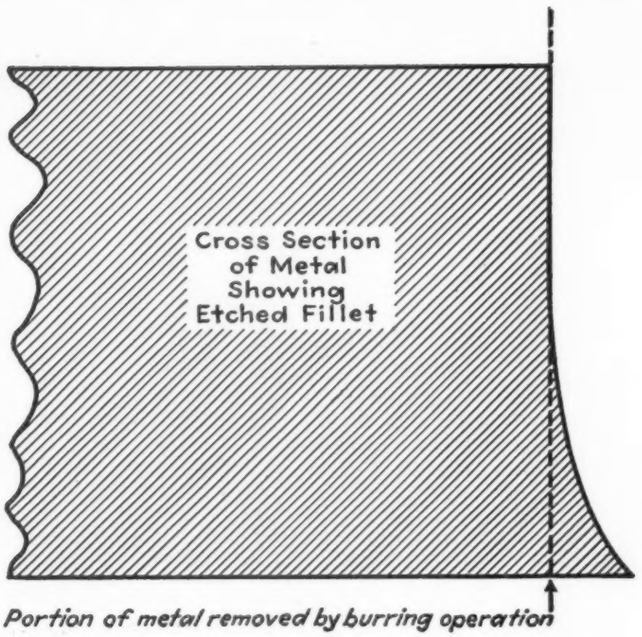
Applying the Sensitizer

The sensitizer may be any colloid such as photo-process glue, gum arabic or resin combined with amonium bichromate, which has the property of hardening under light exposure. A sensitizing medium is available which gives excellent results and keeps indefinitely in its liquid state. This product is purchased ready for use, and while it is made for the entirely different purpose of making printing plates for the lithograph press, it meets the requirements admirably.

At all times attempts have been made to keep this templet process within the limitations of commercially available chemicals and supplies both from the standpoints of availability and economy. The sensitizer used in quite economical. It requires about 4 oz. to cover a 4x6-ft. sheet at slightly over three cents an ounce.

It is applied to the sheet by centrifugal action. While still wet from its water rinse, the sheet is placed in a whirler. This is simply a rotating table enclosed by a circular case with a removable cover. The sensitizer is poured slowly onto the center of the sheet and the whirling action spreads it evenly all over the surface. The cover of the whirler is fitted with electric strip heaters which supply a mild dry heat necessary to accelerate the drying of the sensitizing solution.

It takes approximately 10 min. for the plate to become thoroughly dry. It is now sensitive to bright light but can be handled in subdued daylight or artificial light. No dark room is necessary at all in this process. The plate will stay sensitized without fogging from 6 to 8 hr. which permits considerable flexibility in planning work through the process.



LEFT: Router-block caps of 1/2 in. Kirksite are made complete by etching. RIGHT: The edge of the templet when cut through by the electrolytic process is in the form of an exceptionally smooth fillet. It can be seen that only a small amount of burring is necessary. Undercut is easily held within 0.005 in. by controlling the voltage and amperage.

After the plate is dry and has been removed from the whirler it is placed face up on the table of a vacuum printing frame. This printing frame is in common use in many photographic processes. It consists of a rubber blanket large enough to accommodate the size plate to be used over which is hinged a sheet of ¼-in. plate glass in a frame. The glass frame is so hinged that when it is in its closed position it will seal tightly against a rubber beading around the edge of the blanket. Then, when air is exhausted between the glass and the blanket by a vacuum pump and tank, atmospheric pressure forces the blanket against the glass at a pressure of approximately 14 lb. per sq. in.

Plate Developing

The sensitized plate, face up on the blanket is covered with the negative applied face down. The glass frame is closed and the vacuum applied. This procedure insures absolute contact between the negative and the surface of the plate. Variations in metal thickness are compensated for by the resiliency of the rubber blanket.

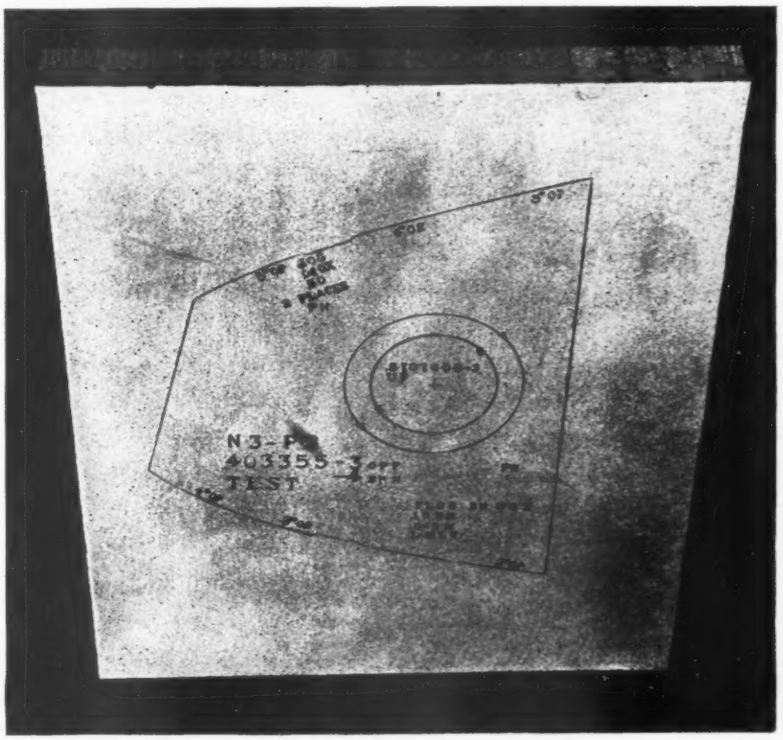
The plate is now exposed through the negative to a source of white light. At the present time a white flame carbon arc is used but experiments have shown that a certain type of fluorescent will work successfully.

Exposure time is about 2 min. The brilliant light passing only through the open portions of the negative completely hardens the corresponding portions of the sensitized plate.

The plate is removed from the printing frame and is placed face up on a flat level table and then developing liquid is applied. The developer contains an agent which dissolves all of the unexposed colloid leaving the original metal and the exposed image.

There are many developer formulas known to the lithographic trade, but again a commercially available product

(*Turn to page* 300)

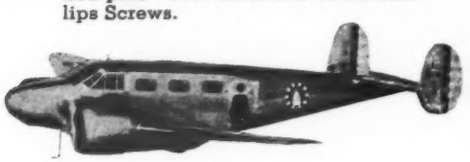


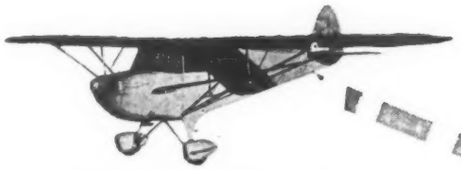
Here is another use for the electrolytic etching process—form-block material which has had the block image developed on its surface.

3 Plusses put the Phillips Recess

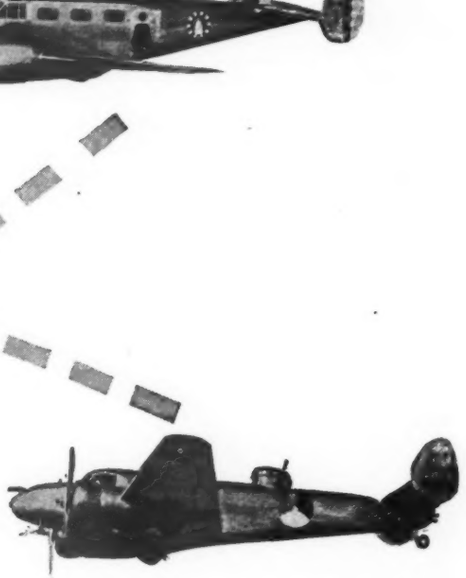
That's why more leading firms are specifying "American PLUS Phillips" on their orders for recessed head screws . . . they get 3 PLUSSES with every shipment.

Beech Aircraft Corp. gets a "production plus" with American PLUS Phillips Screws.





There are PLUS fastenings on planes manufactured by Piper Aircraft Corp.



Lockheed — another famous name in aircraft among American Screw Company customers.

on the Map

American's Engineers

1st of the "3 Plusses" you get when you buy American PLUS Phillips Screws is the assistance of American Screw Company's engineers — the men who pioneered the Phillips Recessed Head on hundreds of assembly lines. Their fund of experience is available to you, for faster driving, fewer operations, an average of 50% lower assembly cost.

American's Laboratories

2nd of the "3 Plusses" is the scientific contro. over the raw materials and manufacturing methods centered in American Screw Company's large chemical and metallurgical laboratories. Here are the testing machines . . . and the technicians . . . that insure the complete dependability of American PLUS Phillips screws year after year.

American's Piece Inspection

Last but not least of the "3 Plusses" is the piece inspection method devised by American Screw Company engineers. . . which insures you against any defects in count or quality.

New Distributors "On the Map" To Give You Quick Delivery

American Screw Company engineering, quality control and piece inspection have put the Phillips Recess "on the map." More and more hardware jobbers and mill supply distributors are stocking American PLUS Phillips Screws for you.

AMERICAN SCREW COMPANY

Providence, R. I.

Chicago, Ill. 589 E. Illinois St.

Detroit, Mich. 1847 W. Bethune St

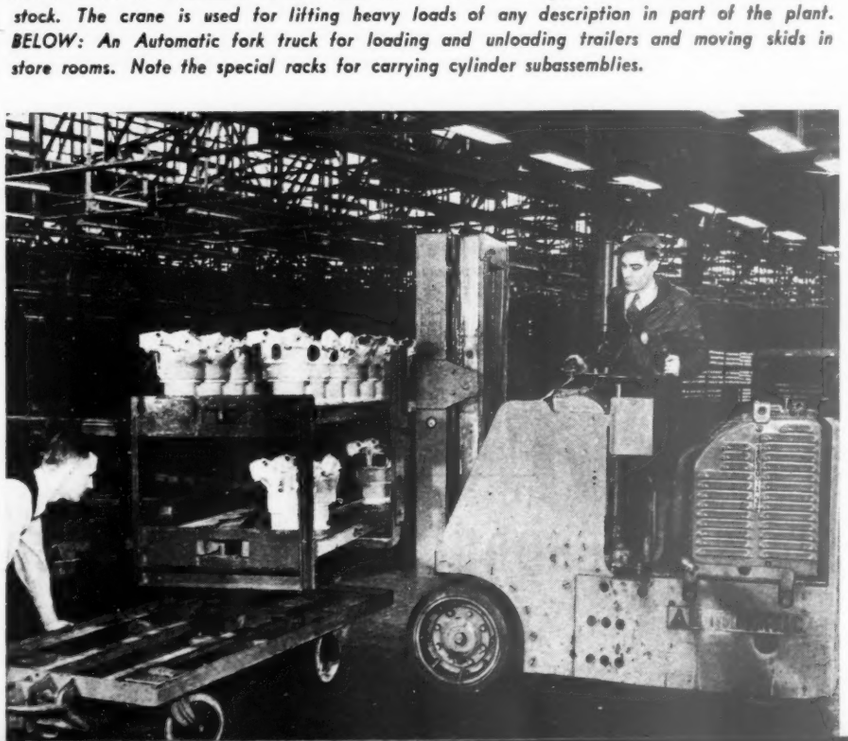
AMERICAN PRODUCED THE PLUS ...

THE PLUS IS PRODUCING FOR AMERICA

Material Handling at Buick . . . .

The flow of production depends on the flow of material. In aircraft engine plants the problem of material handling is complicated by the varying sources of material supply, the time differential between production and assembly, and the need for unusual care in handling precision parts.

ABOVE: Five-ton Automatic crane truck and a trailer with special rack for bar and tubular stock. The crane is used for lifting heavy loads of any description in part of the plant. BELOW: An Automatic fork truck for loading and unloading trailers and moving skids in store rooms. Note the special racks for carrying cylinder subassemblies.



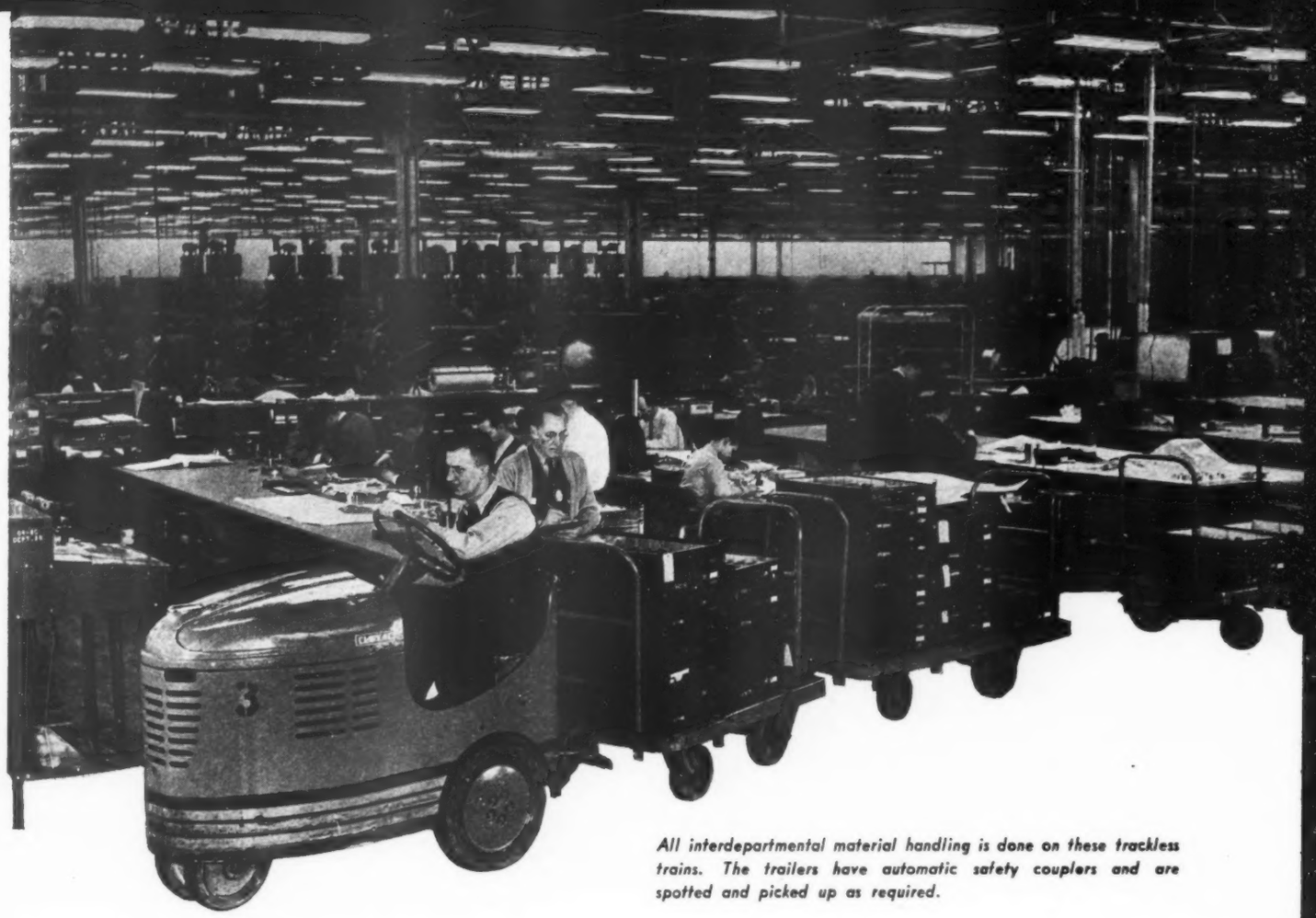
By HERBERT C. CHASE

IN THE MASS PRODUCTION of such high precision machines as aircraft engines, a number of problems concerning the handling and control of material are encountered that do not exist, for example, in the production of automobile engines.

The flow of material is relatively slow because of the large number and precision character of the operations required. In addition, highly special precautions are needed to avoid marring parts in progress or finished. A continuous flow from production to assembly is not possible because of the large differentials in the operations with respect to time. Furthermore, a large number of preassembled parts come from outside sources. Therefore, considerable storage facilities must be provided for finished parts, rough forgings, castings and the like. For such reasons it is not feasible to employ power driven conveyors, with one or two minor exceptions, and gravity conveyors are used only in some production departments.

In the Buick plant, the flow is necessarily intermittent but it does follow a well-considered plan and may be regarded as continuous in the sense that much material is constantly flowing from incoming cars and raw material storage to many production departments and from them back through storage for finished parts, called the "bond room," to assemblies. Even the assembled engines are not immediately shipped. Every one has to be tested first, then completely dismantled, inspected, reassembled and run before boxing for shipment can be done. This, too, adds to the problems of material handling.

The plant area over which the material must be distributed is considerable. As far as the production departments are concerned, the general plan is to deliver the raw material along aisles and have it flow through production



All interdepartmental material handling is done on these trackless trains. The trailers have automatic safety couplers and are spotted and picked up as required.

departments toward other aisles where inspection takes place and the parts are then picked up and delivered to the bond room and those which require further processing are delivered to other production departments.

Both raw and finished materials, as well as some completed parts coming from outside sources are received and unloaded on a siding and in most cases are then loaded onto skids or trailers for transfer into an inspection department for checking against specifications. Fork trucks handle skid loads and a tractor moves the trailers as required. Materials are shifted into rough stock storage as rapidly as inspection can be completed, or, in the case of finished parts or accessories, delivery to the bond room follows completion of inspection.

Efficient Use of Tractors

Nearly all the bulk handling operations, except certain loading and unloading, is done on well built Mercury trailers equipped with rubber tired casters on Hyatt bearings. Most of these are platform types, the prevailing size being about 36x66 in. Others have the same width but are longer, in some instances, to carry long stock such as bars and tubes. Some are equipped with special racks. In all, about 200 of these trailers were in use, when data for this article were collected, but more were on order and will be put into service as required. Eight Clarkat gasoline tractors are provided for handling trailer loads up to four in number and these trackless trains are constantly on the move, handling, as far as possible, the full number of trailers.

To gain full utility of the tractors, they are kept in nearly constant motion, except for short stops to drop trailers and pick up others, which can be done, as a rule, without the operator leaving his seat. Operators are not allowed to load or unload trailers but, as far as practical, are required to pick up loads for a common destination and to run without loads as little as conditions permit. Specific routes are not set, but the routes in general, follow outside aisles with loads of raw stock and return through center aisles with finished or partly fabricated parts. Empties also have to be shifted about as required and loads of finished or partly finished parts have to be delivered to the destinations intended.

Empties are dropped off where loads are ready and when the trailers have been loaded they are picked up and towed to required destinations. Loads from the stockrooms are moved under requisitions and are marked, of course, for the departments making the requisitions. When a load is ready to be moved from a production department, it is marked with a tag of such color as to indicate its destination. Thus a red tag may indicate the heat treating department, blue the plating department, yellow the bond room, etc. This facilitates picking up a full load for a common destination without stopping to read tags. There are stations for receiving loads at the starting end of the production departments and stations for dispatching them, after inspection from the finish end of the departments. Loaded trailers must be unloaded with reasonable promptness and empties must not be held unduly long for loading.

Racks for Heavy Loads

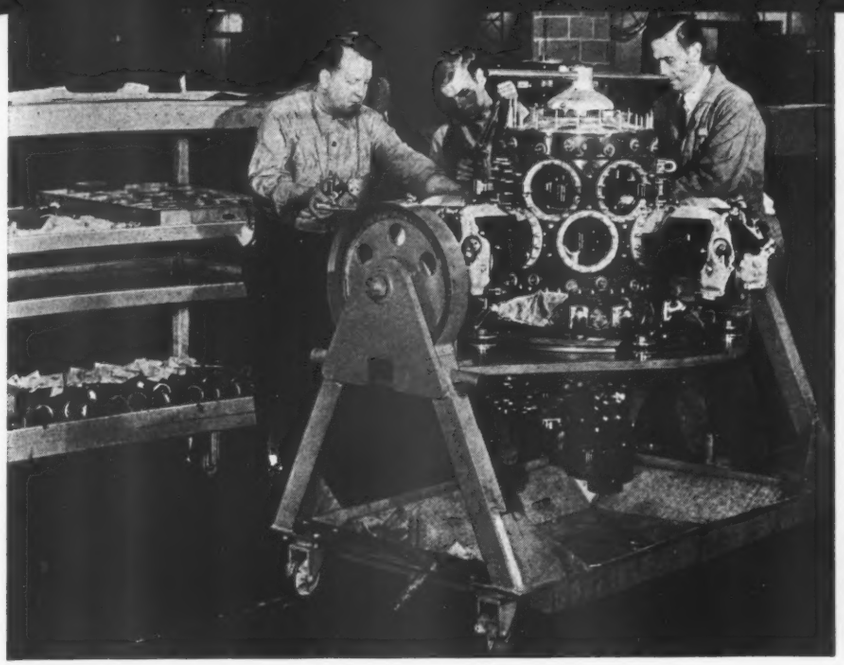
Loads which are too heavy to be lifted by hand are lifted off and onto trailers either by one of two forked trucks or by a crane truck, all of which are self-propelled and power operated by gasoline engines. These trucks also circulate as required through the plant but, as the trailers are spotted until loaded and unloaded, such loading does not interfere with or delay regular operation of the trailer trains. All trailers are light

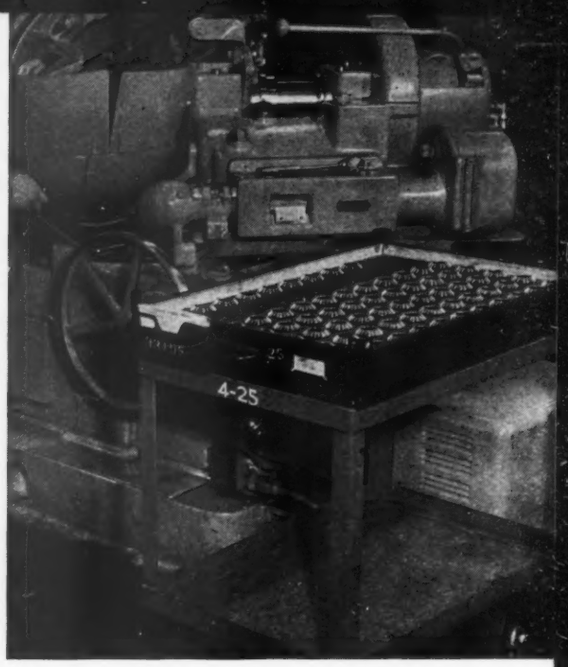
THE MAJORITY of *Twin Engine* TRAINERS are powered by...

JACOBS *Engines*

JACOBS AIRCRAFT ENGINE CO.

Pottstown, Pennsylvania, U. S. A.





ABOVE LEFT: Special engine assembly dollie. Note the shelf racks in the background for assembly parts delivered from the bond room. ABOVE RIGHT: Wheeled dollies shift trays of parts from machine to machine and to inspection stations. Some departments use roller conveyors. LEFT: Standard trays equipped with hole-boards, peg-boards, or dividers. All trays nest in angle fittings at corners.

enough to be moved easily by hand within the loading and unloading areas.

Forgings, castings, bar stock and other heavy loads are usually handled on special racks, in tubs or on skids which are spotted at the required unloading points and are there unloaded from trailers onto the floor. The unloading is done adjacent to the initial operation where the pieces or bar can be fed into the first machine. From that point on, the transfer within departments is usually on wheeled dollies, generally in trays, though where a straight production line is set up, roller conveyors are used.

All except a few of the largest parts are handled in specially partitioned trays or in hole- or peg-boards in trays. The latter are of a standard 20x30-in. size, made to nest readily. Two standard heights of trays, 4 in. and 6 in., are provided and if deeper trays are needed they are built up from these heights fastened together. Tray bottoms, partitions and hole boards are of plywood, mostly cut to standard sets of sizes which are stocked and can be assembled quickly to meet requirements. Although the tray frames are steel, they are lined with wood and parts in process or finished and kept out of contact with each other by wooden partitions, holes or pegs. In certain special cases, even paper cartons are provided for each part, made from a special grade of strong paper free from any corroding tendency. In general, a dozen or more identical parts are carried in a tray. However, three or more different parts may be grouped in a given tray, particularly in the case of certain gears where mating sets are involved.

Trays are moved on wheeled dollies until they reach the inspection benches where they are unloaded by hand. After inspection and a load sufficient for a trailer has accumulated, the trays are again shifted by hand onto a trailer for dispatch to the next department.

Cylinder Racks

A few parts, such as cylinder subassemblies are handled on special racks. Those for cylinders are made from heavy planks having holes in which the end of the cylinder barrel fits. This is done because the shape of this part is somewhat awkward to handle otherwise and is best protected against injury by such handling. The planks of this frame are supported on metal frames to form a unit which is lifted onto and off of trailers by one of the forked trucks. When filled, such a rack carries two complete sets of cylinders or enough to supply two engine assemblies. The filled racks are delivered to the bond room for issue to the engine assembly department. There the cylinders are shifted, one at a time from the rack into the assembly. Then the racks are returned to the department making the subassembly.

Although a standard size and shape of wheeled dollie of bench height is employed in most of the production departments, a few specials are required. One of these is used for aluminum crankcase forgings, the faces of which are lapped to provide tight joints without gaskets. Scratching of these faces might necessitate scrapping the part, hence special care in protecting the face is exercised. The wheeled dollie, in this case, has a fibre floor and hinged sheets of fibre are so arranged that six forgings can be stacked one above the other with a sheet of fibre between. Such is

(*Turn to page* 309)

Standardization of Small Tools

Successful mass production of anything depends on the greatest possible standardization of material, production method, and tools. Now that airplanes are a mass production item, uniform tool standards have a special significance.

By WADE E. MILLER
President, Aircraft Tools, Inc.

IMPORTANT SAVINGS IN production time, as well as materials, have been gained for aircraft construction through the standardization of tooling equipment. The establishment of tool standards has been of particular advantage to new companies entering aircraft production, as well as to every company employing inexperienced workers. The value of this program has been emphasized by emergency production schedules now in effect throughout the industry.

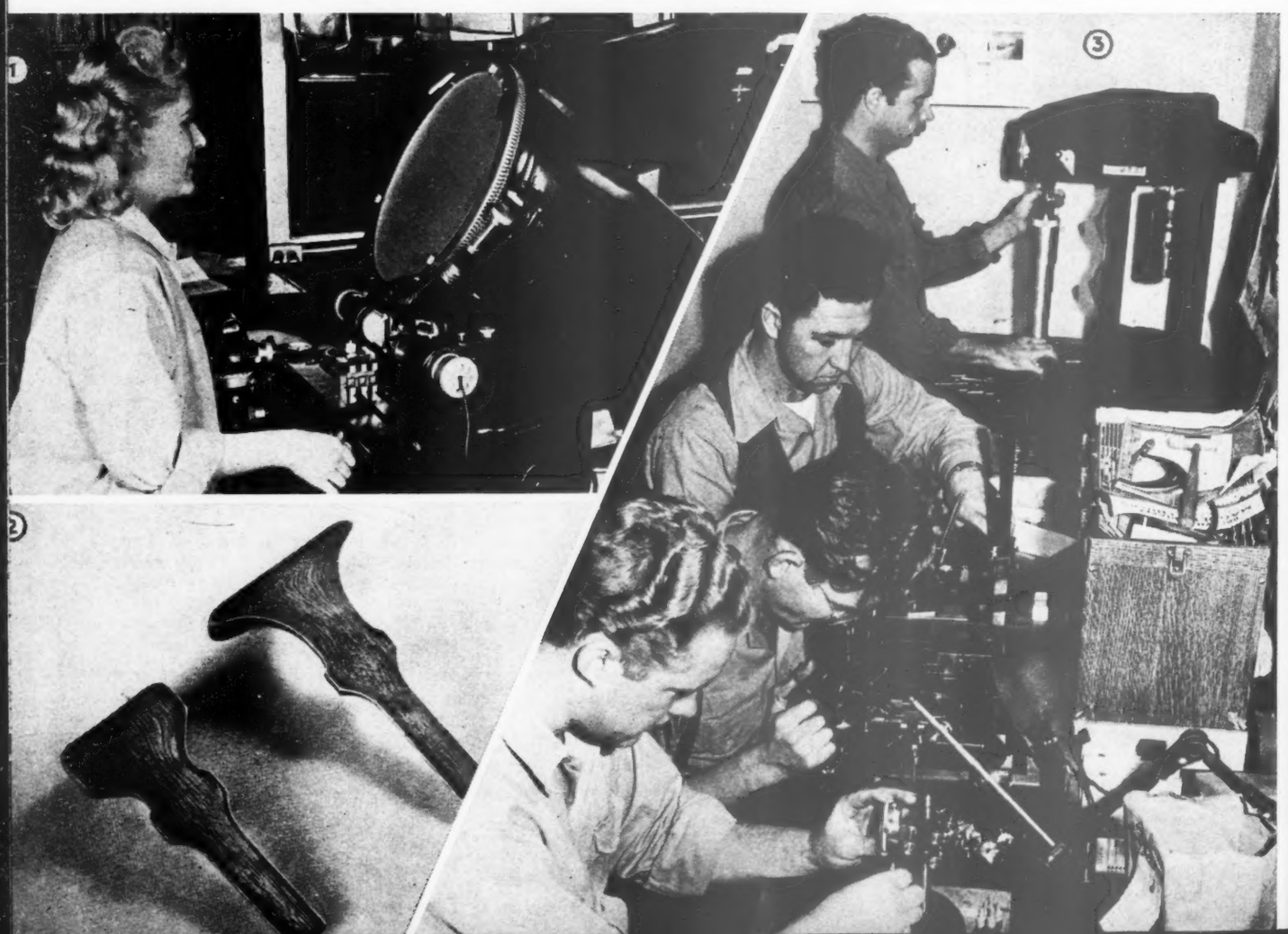
Standardization of small tools was well developed before the present War Production Board standardization program was conceived, and has been an important contribution to war production. This program has received the thorough cooperation and approval of virtually all major aircraft companies and airlines. Government bids for the Army and Navy now include specifications for materials, heat treatment, dimensions and cup diameters that have been established as standard by the company.

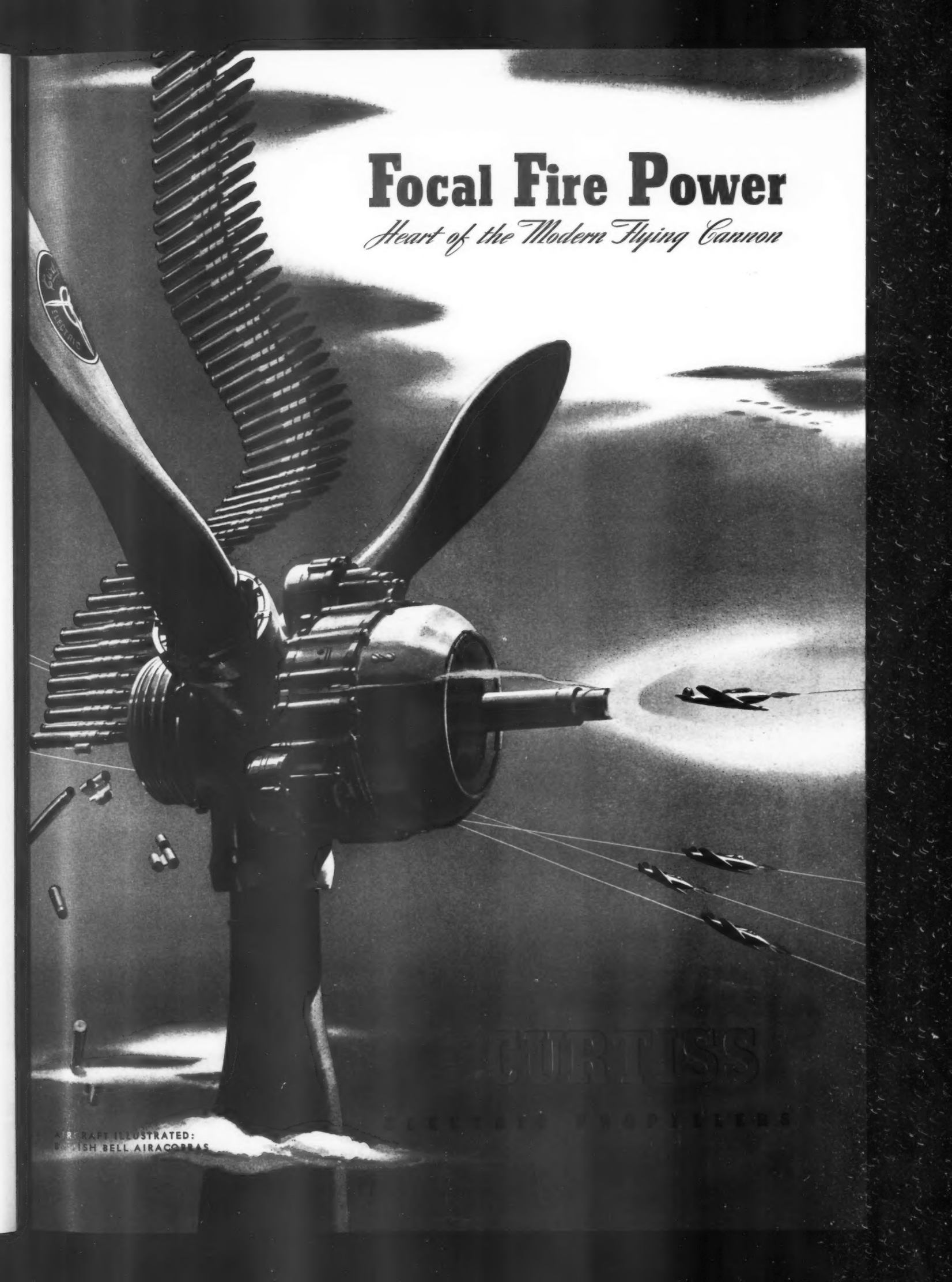
The advantages of tool standardization have been particularly emphasized under war conditions. New companies, converted from automobile or other industries, must make quick adjustments to their present work. They are faced with a multitude of problems. To find their tooling requirements standardized has been an important advantage, and sincerely welcomed by these newcomers to the industry.

In the early days of aviation, when an airplane was built principally of wood, glue and fabrics, tooling was not the principal problem. As evolution took place, metal skins replaced fabrics, and metal spars replaced wood, new tools had to be devised to fabricate these new airplanes.

(*Turn to page 304*)

FIG. 1. All precision tools are checked on the comparator at Aircraft Tools, Inc. The instrument magnifies up to 100 times. FIG. 2. Forged rivet sets with grain flow following each radius have vastly improved the fatigue characteristics of these much used assembly tools. FIG. 3. Comprehensive inspection of new tools is essential to the maintenance of uniform standards.

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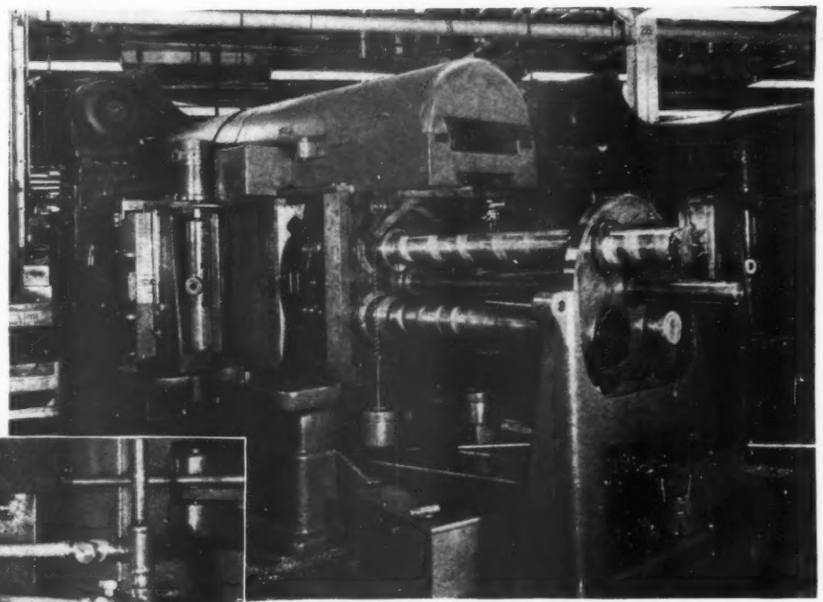
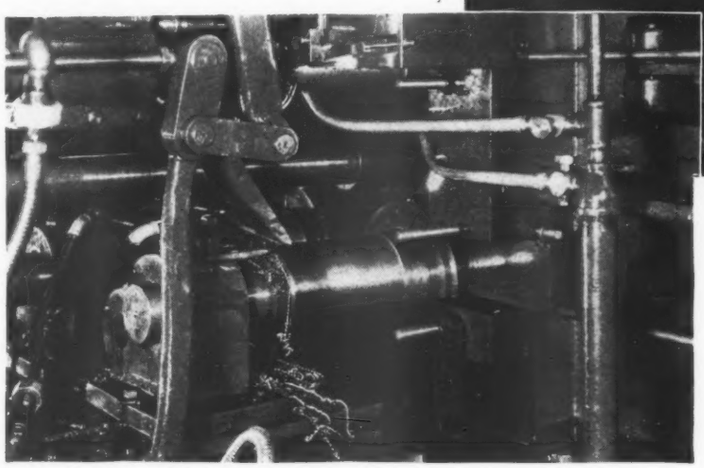
Rolls Cylinder Liners Cut From Seamless Steel Tubing



RIGHT: One of the four-spindle Cone automatics on which the lengths of seamless alloy steel tubing for cylinder liners receives the initial machining and is cut off into lengths for subsequent machining. BELOW: Close view of machining in a Conomatic, in which the od. is turned, the end faced, a collar is formed and the id. is rough bored before the piece is cut off. Stellite tools are used.



CYLINDER LINERS for Rolls Royce engines manufactured by the Packard Motor Car Company are turned from seamless steel tubing having a heavy wall. This method of production is economical in the chrome-molybdenum steel (AMS 6380, equivalent to SAE 4140) employed and avoids the forging operations by which cylinder barrels for many aircraft engines are made. In this instance, of course, the cylinder barrel (it is not, strictly speaking, a "liner," though so termed) is for a liquid cooled engine and thus does not require the cooling fins needed for aircooled engines. For this reason, and because a much narrower flange is employed, a wall thickness, such as is produced in forgings, is not required.

Seamless tubing chosen for this liner is 6⅛ in. od. and has a ⅝-in. wall. It is supplied in lengths of 10 ft. 5 in. which can be cut with minimum waste into the lengths needed. Initial machining is done in six-inch, four-spindle Cone automatics. In the first position on these machines the od. is turned, the end is faced and the first third of the id. is rough bored. Another third of the bore is roughed in the second position and the remainder of the rough boring is done in the third position, where a collar or flange is also formed. Cutting off only is done in the fourth position, the length being held within the limits of 9.295 and 9.305 in. Stellite tools are employed for boring and high-speed steel tools for turning operation, most of the cuts being about ⅛ in. deep. Spindles turn at 39 rpm.

Before further machining is done, the rough cylinders are sent to the heat-treating department for normalizing. They are then put through a Cincinnati centerless grinder which rough grinds the od. for subsequent chucking in a Potter & Johnston turret lathe in which a second boring cut is made on two liners at a time. This machine is provided with a special fixture made to receive two liners at each end. While two are being bored, two at the opposite end are being unloaded and two more loaded in their place. When the boring is completed and the ends faced, the fixture is indexed 180 deg. and the pair previously loaded are machined while the opposite end is unloaded and reloaded.

Next, the liners are passed along a roller conveyor, which advances them from machine to machine, and are moved to a Low-Swing lathe where they are mounted one at a time on an expanding arbor for turning all outside diameters. This machine is equipped with 16 carbide tools, 11 in the back holder and 5 in that at the front. The piece turns at 75 rpm. and the tools remove from 0.060 to 0.020 in. of metal, leaving 0.030 in. for subsequent removal by grinding, after the liner has been hardened. The latter is done, of course, in a separate heat-treating department and

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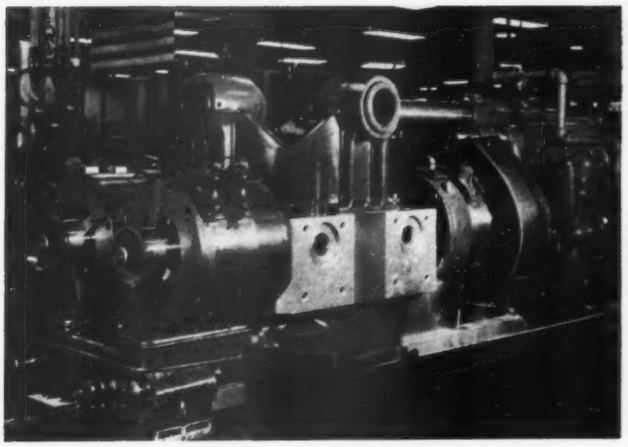
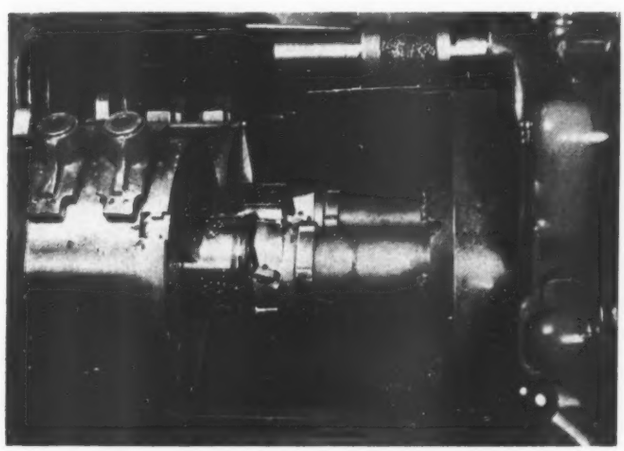
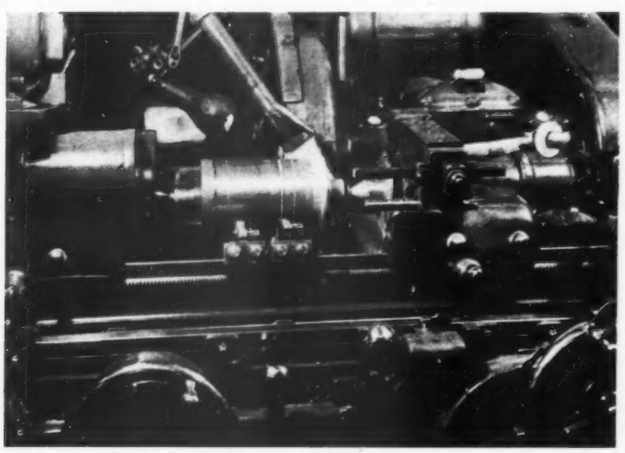


LEFT: Cylinder liner in a Cincinnati centerless grinder which performs the rough grinding of the od. before the piece is chucked on the od. for boring on a Potter & Johnston. RIGHT: Setup in a Potter & Johnston turret lathe in which the second boring operation is performed. The two chucks in foreground are unloaded and reloaded while the two on the far side are in position for the boring which is in progress.





LEFT: In this view, the tools which perform the machining on the Potter & Johnston are shown, two liners being bored and the ends faced simultaneously. Then the turret is indexed 180 deg. to bring another pair of liners into machining position while two just machined are unloaded. RIGHT: Turning the outside diameter in a Lo-Swing lathe equipped with 16 carbide tools, in all, in the two holders, front and back.

it results in a Rockwell hardness of 38 to 42.

After return from hardening, liners go in succession through three Cincinnati centerless grinders which finish the long od. to the limits 5.638 and 5.643 in. Also ground on these machines are radii of 0.100 and 0.050 in., respectively, and an od. termed the "main bearing." This locating surface is below the flange and subsequently (after plating and other operations) makes a fit with the cylinder block. The outside of the flange is also ground in these operations. To permit of grinding on these diameters, the machines are fitted with profile cams and each machine has three diamonds for redressing the wheels after every ten pieces are ground. The three machines perform, respectively, rough, medium and finish grinding and take off, in all, 0.030 in. of metal.

For the next operation, the liner goes to a Bryant grinder where it is placed in a pot chuck, which locates it on the main bearing surface. This machine grinds the face of the collar and one end face, establishing locating surfaces for subsequent grinding of the bore. This latter operation is done on another Bryant machine which removes 0.030 in. of metal and increases the bore to 5.390 in. Then the piece is mounted on an arbor in a Bradford lathe to turn a 5-deg. angle on a diameter under the flange, from a 26½-deg. chamfer 0.060 in. wide and two radii of 0.050 and 0.037 in. respectively. While still mounted on the same arbor, the piece is shifted to a 10x36 Norton which grinds a minor flange diameter within the limits of 5.804 and 5.805 in.

The next Norton grinds the od. of three rings, holding the dimension within the limits of 5.777 and 5.779 in. Another Norton is used to grind the slots between the rings, holding the widths between 0.363 and 0.358 in. and the diameter between 5.640 and 5.641 in. Still another Norton, equipped with a profile cam for controlling a blade having two diamonds to true the stone, grinds four od. dimensions, four angles and four radii below the rings.

During the heat-treatments previously mentioned and between the foregoing machining operations, brass tags attached by a wire are used to identify the individual liners by number. After the last mentioned grinding, however, a rubber stamp is employed to apply acid for etching identifying numbers at designated points on the od. and the id. The numbers relate to the heat (of steel) in the mill where the tubing is produced, and enable inspectors to follow the material through from raw stock to finished piece.

After the last mentioned grind and etching, liners are subjected to Magna-

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fluxing, the purpose of which, of course, is to locate any flaw or crack in the steel by magnetic means. The liner is mounted in a holder so arranged that a current of 3,600 amp. can be passed through the liner momentarily, to set up a magnetic circuit. During this interval the piece is immersed in kerosene containing iron oxide particles which are kept in suspension through agitation of the liquid by pumps. Any flaws in the metal cause an intensification of the magnetic flux at the point where they occur and a corresponding attraction for the iron oxide particles. These accumulate at the flaw and reveal its presence as well as its location, even though it be too fine for detection by the eye or below the surface where it would remain undetected otherwise. Careful visual inspection under fluorescent light follows the Magnafluxing and, unless a flaw is revealed, the part is cleaned, demagnetized, and oiled for delivery to the plating department.

Plating of all outside diameters is done in such a way that they receive from 0.005 to 0.007 in. of nickel. This is applied as a protection against corrosion in contact with the liquid used for cooling the liner in service. The nickel is rather soft to use as a locating surface where the liner is clamped in the cylinder block. Hence the main bearing surface is subsequently ground down so as to leave only 0.003 in. of nickel and the surface thus ground is then given a coat of hard chromium by plating thereon to a thickness of 0.00075 in.

After the nickel plating, the liner is returned to the machining department and is placed in a Brown & Sharpe grinder for semi-finishing the od. of the collar and that of the main bearing, partly for chucking in a Bryant grinder. In the latter, the bore is given a semi-finish grind, being held within the limits of 5.392 and 5.393 in. This provides a surface for locating on an arbor on which the liner goes successively through six Norton grinders which perform, respectively, the following operations:

- Grind od. of slot, holding limits of 5.646 and 5.647 in.
- Grind od. of three ribs between limits of 5.785 and 5.787 in.
- Grind od. of collar between limits of 6.0575 and 6.0595 in.
- Grind od. of narrow flange under collar between limits of 5.809 and 5.811 in.
- Grind profile of four diameters on end opposite flange, four angles and four radii to final finish.
- Grind finish width of collar between limits of 0.149 and 0.151 in. and of od. above flange to 5.546 and 5.548 in., also a 0.025-in. radius.

These operations finish all outside grinding, but liners are passed through two speed lathe operations for the purpose of burring all sharp edges with No. 320 emery cloth. After this, the sleeves are inspected and are ready for chrome plating the ribs and the main bearing surface.

Subsequent to this plating, the liners are returned to a speed lathe where any sharp edges are smoothed with emery cloth and any acid stains are similarly removed. Both faces of the collar are then lapped in a hand operation in which the cylindrical portions of the liner project through a hole in the lapping plate. The od. of the collar is also lapped in this operation.

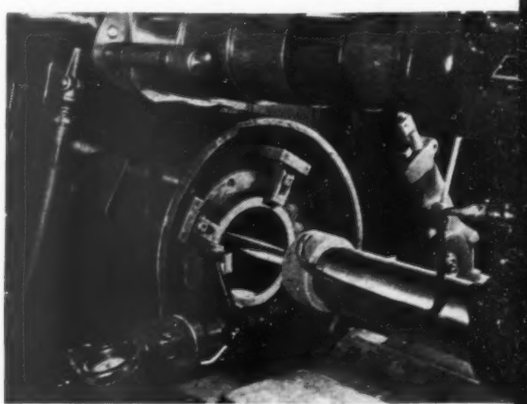
Final grinding of the bore is done in a Bryant grinder in which the piece is chucked on the main bearing surface and against the collar, which are locating points when the liner is subsequently fastened into the cylinder block. In this grinding, the bore is sized within the limits of 5.400 and 5.401 in., after which the finished piece is ready for final inspection. The latter is done by several inspectors at a special bench reserved for the purpose, using gages provided to check all significant dimensions. This work is, of course, in addition to that done in checking dimensions at the machines after each operation. Such checks are made chiefly with dial gages which are set from master gages. In some instances, the dial gages are arranged in special fixtures which hold them in convenient position for checking the dimensions involved. All Norton grinders are provided with dial gages on supporting arms so arranged that checking of sizes is rapidly done as the grinding proceeds.

Handled With Care

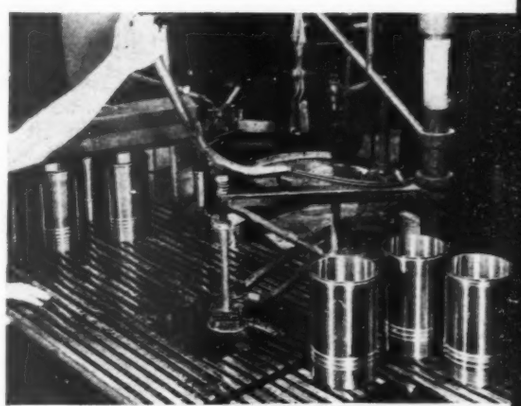
If final inspection indicates that the bore is not sufficiently smooth, some honing is done subsequently, but this is not required as a rule. Special care is exercised in handling the liners between operations, particularly after the first of the finish grinding and all operations following it, as scratching or marring may result in rejections which proper care avoids. A separate carton for each sleeve is provided and is employed in handling after the roughing stages of production are passed, except where machine operators themselves carry the sleeves individually from machine to machine.

As will be seen, the operations outlined are very much on a par with those on engines of American design intended for similar service, though they naturally deviate in details to meet differences in design and in the construction called for. Equipment employed was chosen, of course, especially for the operations needed and contributes its share to the high grade of product turned out, as does also the long experience of the Packard organization in precision production.

One of the several internal grinding operations which are performed on Bryant grinders.

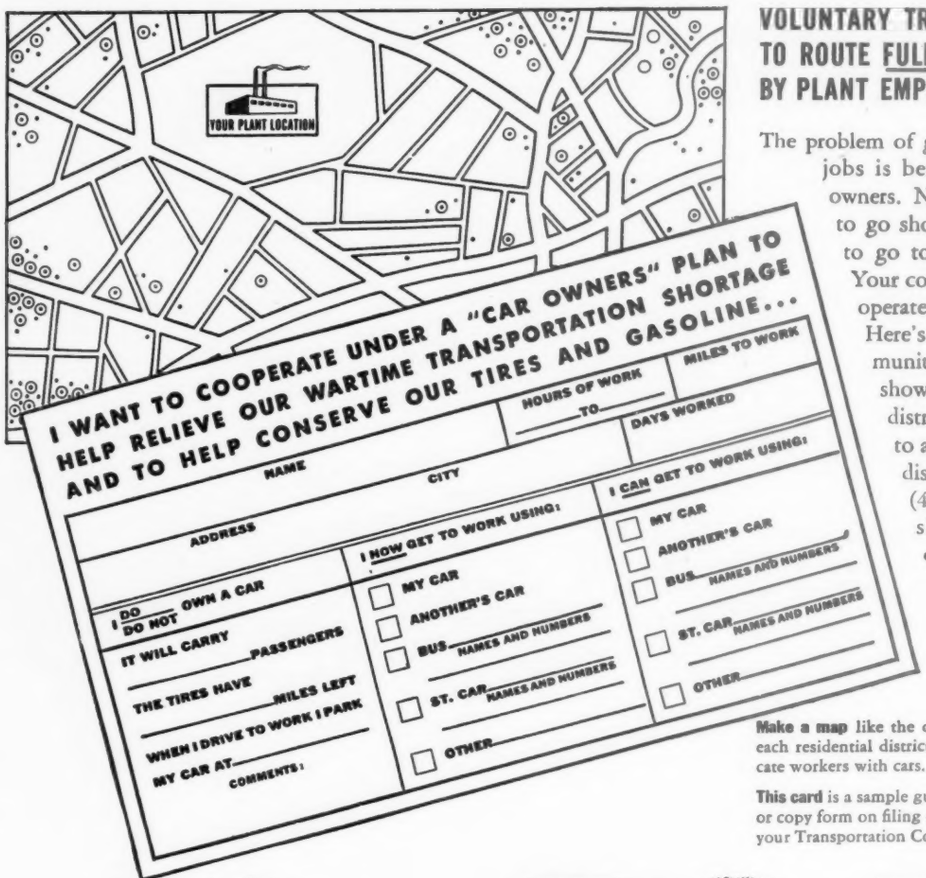


Setup for Magnafluxing cylinder liners after several of the grinding operations are completed. Magnafluxing is done in the well near the center of the illustration and, after inspection for any cracks which may be revealed, is demagnetized in the nearer well.



Close view of the fixture used for gaging after the nickel plated surface has been ground to size. Four different diameters are gaged as the liner is rolled from left to right through the fixture.

MANY LARGE COMPANIES ARE NOW TAKING A CENSUS OF EMPLOYEES' CARS AS PART OF NATION'S PROGRAM TO GET 40,000,000 WORKERS TO THEIR JOBS ON TIME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NAME
CITY
HOURS OF WORK
TO
MILES TO WORK
DAYS WORKED
ADDRESS
I DO / DO NOT OWN A CAR
IT WILL CARRY ____PASSENGERS
THE TIRES HAVE ____MILES LEFT
WHEN I DRIVE TO WORK I PARK
MY CAR AT
COMMENTS:
I NOW GET TO WORK USING:
MY CAR
ANOTHER'S CAR
BUS NAMES AND NUMBERS
ST. CAR NAMES AND NUMBERS
OTHER
I CAN GET TO WORK USING:
MY CAR
ANOTHER'S CAR
BUS NAMES AND NUMBERS
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VOLUNTARY TRANSPORTATION COMMITTEES TO ROUTE FULL CARS TO WORK ARE SET UP BY PLANT EMPLOYEES IN EACH COMMUNITY

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Make a map like the one above, on which to chart the routes for each residential district. Dots indicate workers' homes; circles indicate workers with cars.

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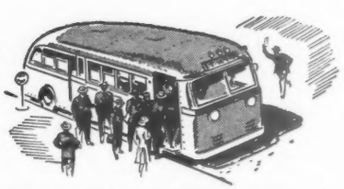

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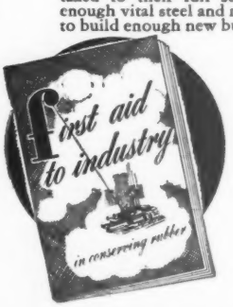

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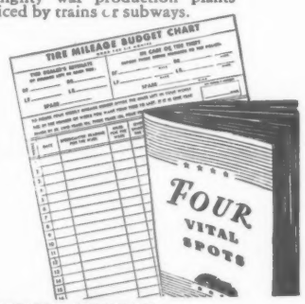

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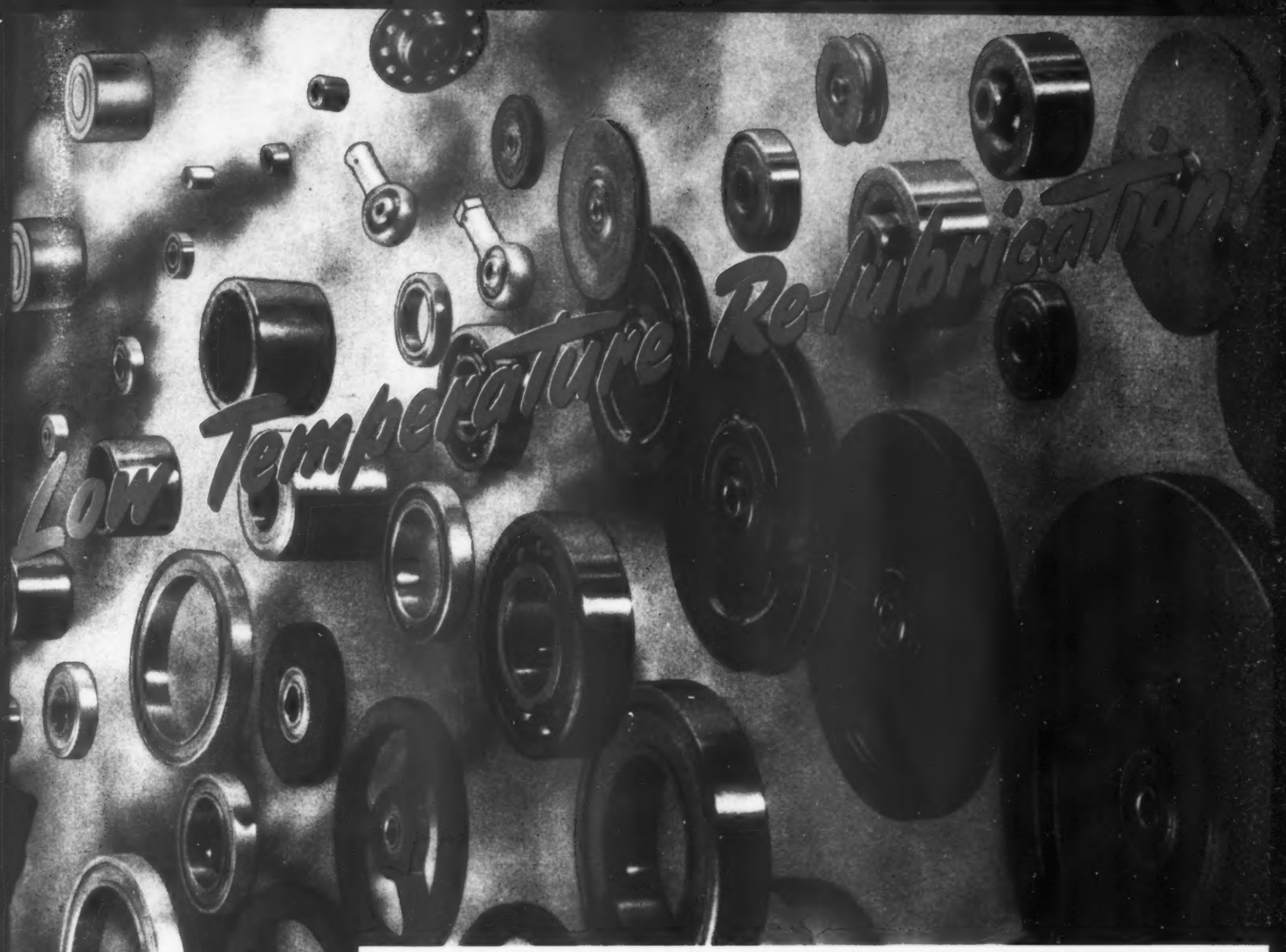

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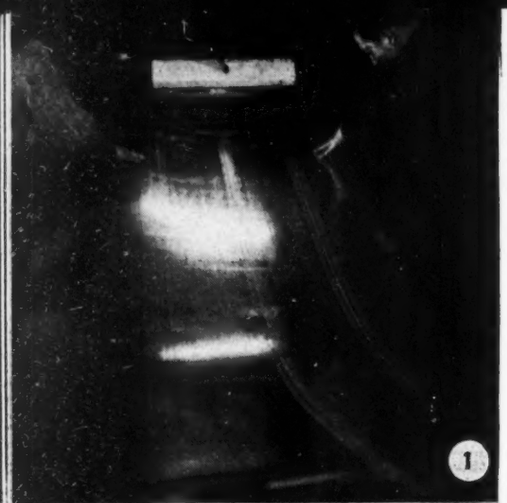

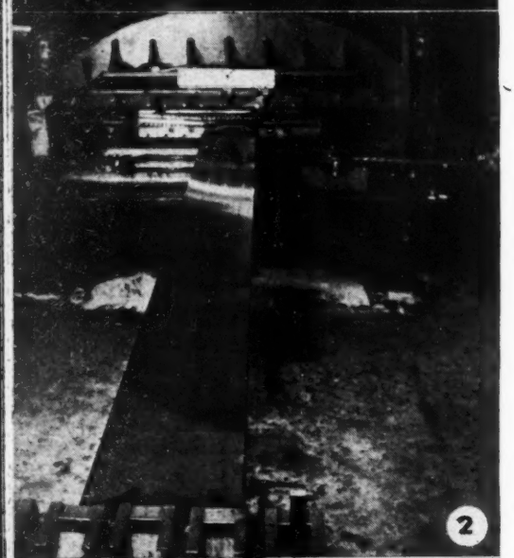

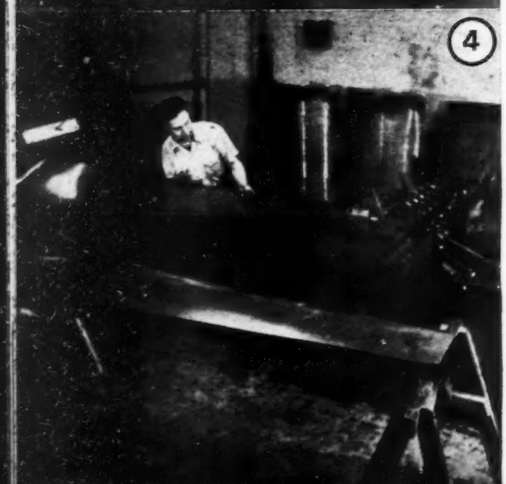

FORMING BY-DRAWING

PART II—Last month's article described the method of operation and utilization of the Forming-by-Drawing machine. This concluding part is devoted largely to discussion of the savings in materials, production time, plant space, storage facilities and power which are gained by this method of forming airframe skin panels.

By FROHMAN ANDERSON
President, Anderson Aircraft, Inc.

THE GENERAL ASPECTS of the Forming-by-Drawing process and machines for the production of airframe compound curved skin panels were described in the June issue of AVIATION.

The present article, in emphasizing some of the features of this new metal forming technique, with their cumulative advantages, sets forth its value to the war production effort and shows how materials, men and money can be conserved and strategically diverted.

Many means and methods for handling metal in the scrap state, saving millions of dollars a year, are being practiced today. This activity, now a *major* division of the aircraft industry, is called Material Conservation. It must be remembered that the maintenance of this division runs into considerable expense and every effort should be made to cut down its amount of "business."

As the volume of airplane production doubles and redoubles, the aluminum scrap heap spreads like an epidemic. Any endeavor diligently directed to *prevention* rather than *cure* of scrap is patriotic. If millions of pounds of "fresh" aluminum can be conserved, there will be thousands of extra fighter planes.

The plaint of some aircraft executives over the unavoidable, inadequate allocations and slow deliveries of strategic aluminum should be directed to a demand for planning and methods that result in a minimum of waste. The appalling waste of aluminum in every aircraft plant can and should be stemmed.

The Anderson Forming-by-Drawing technique, now an important adjunct to aircraft skin panel production, is providing an answer to imperatively urgent sheet aluminum stock economies.

Furthermore, the inherent qualities of this new process can lead to the conservation of (*a*) millions of skilled manhours per year; (*b*) millions of kw hours of electric power (not considering the electric power for the reduction of aluminum); (*c*) thousands of tons of materials now being used for making conventional forming tools and dies; and (*d*) millions of dollars worth of heavy presses, etc.

Careful cost estimates reveal the vast possibilities for enormous savings in the application of the Forming-by-Drawing process through careful study of various airframe skin panel joint line and assembly layouts.

Concentrating for the moment on the conservation of aluminum sheet stock by the use of this process, the various illustrations in this and the June article are self-explanatory and may be summarized as follows:

Saving of sheet metal stock due to:

1. Ability to utilize entire surface of flat sheet except for one or two inches at the ends, results in substantial savings amounting to as much as 50 per cent,
2. Ability to form pre-blanked sheets

FIG. 1. Producing a skin panel in one piece for Curtiss-Wright military transport door. FIG. 2. Any length or hardness of material accurately responds to action of Forming-by-Drawing operation. FIG. 3. The careful adjustment of forming elements reproduces skin panels to fit fixture accurately. FIG. 4. One to two operators are required to operate the Forming-by-Drawing production runs.

FORMING MACHINES FOR AIRFRAME SKIN PANELS COMPARED

	NUMBER OF OPERATORS	WEIGHT OF MACHINE	APPROX. COST OF MACHINE	POWER	DEVELOPED PRESSURE	HEIGHT ABOVE FLOOR	FLOOR SPACE AND FOUNDATION	SIZE OF FINISHED PANELS	TYPICAL FUSELAGE: NUMBER OF SKIN PANELS REQUIRED	TYPICAL FUSELAGE: NUMBER OF DIFFERENT TOOLS	TYPICAL FUSELAGE: TOOL STORAGE FOR DUPLICATE ORDERS	COMMON PERCENTAGE OF SCRAP PER PANEL
TOGGLE PRESS		450 TONS	UP TO $500,000	250 HP.	750 TONS	25 FT.	10 FT. x 20 FT. SPECIAL FOUNDATION AND PIT.	56" x 90"	45	45	STORAGE SPACE FOR COMPLETE SETS OF DIES	FROM 12% TO 30%
HYDRO PRESS		350 TONS	UP TO $200,000	335 HP.	3,500 TONS	29 FT.	18 FT. x 30 FT. SPECIAL FOUNDATION AND PIT	44" x 90"	45	45	STORAGE SPACE FOR COMPLETE SETS OF DIES	FROM 0% TO 25%
DROP HAMMER		16 TONS	$ 11,000	10 HP.	IMPACT	12 FT.	5 FT. x 7 FT. SPECIAL SHOCK ABSORBING FOUNDATION AND PIT	44" x 44"	60	60	STORAGE SPACE FOR COMPLETE SETS OF DIES	FROM 0% TO 25%
STRETCH PRESS		16 TONS	$ 30,000 TO $ 70,000	4 HP.	150 TO 300 TONS	5 FT.	12 FT. x 20 FT. SPECIAL FOUNDATION AND PIT	44" x 120"	45	45	STORAGE SPACE FOR COMPLETE SETS OF DIES	FROM 10% TO 50%
FORMING-BY-DRAWING		7 TONS	$ 20,000	15 HP.	DRAW	5 FT.	8 FT. x 50 FT. STANDARD LEVEL FLOOR 250 LB./SQ. IN.	66" x 290"	20	1	RECORD CARD	FROM 1% TO 5%

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For the air power of America and her allies, Lockheed is producing P-38 "Lightning" interceptor pursuits... and Lockheed Hudson bombers. Lockheed Aircraft Corporation, Burbank, California.

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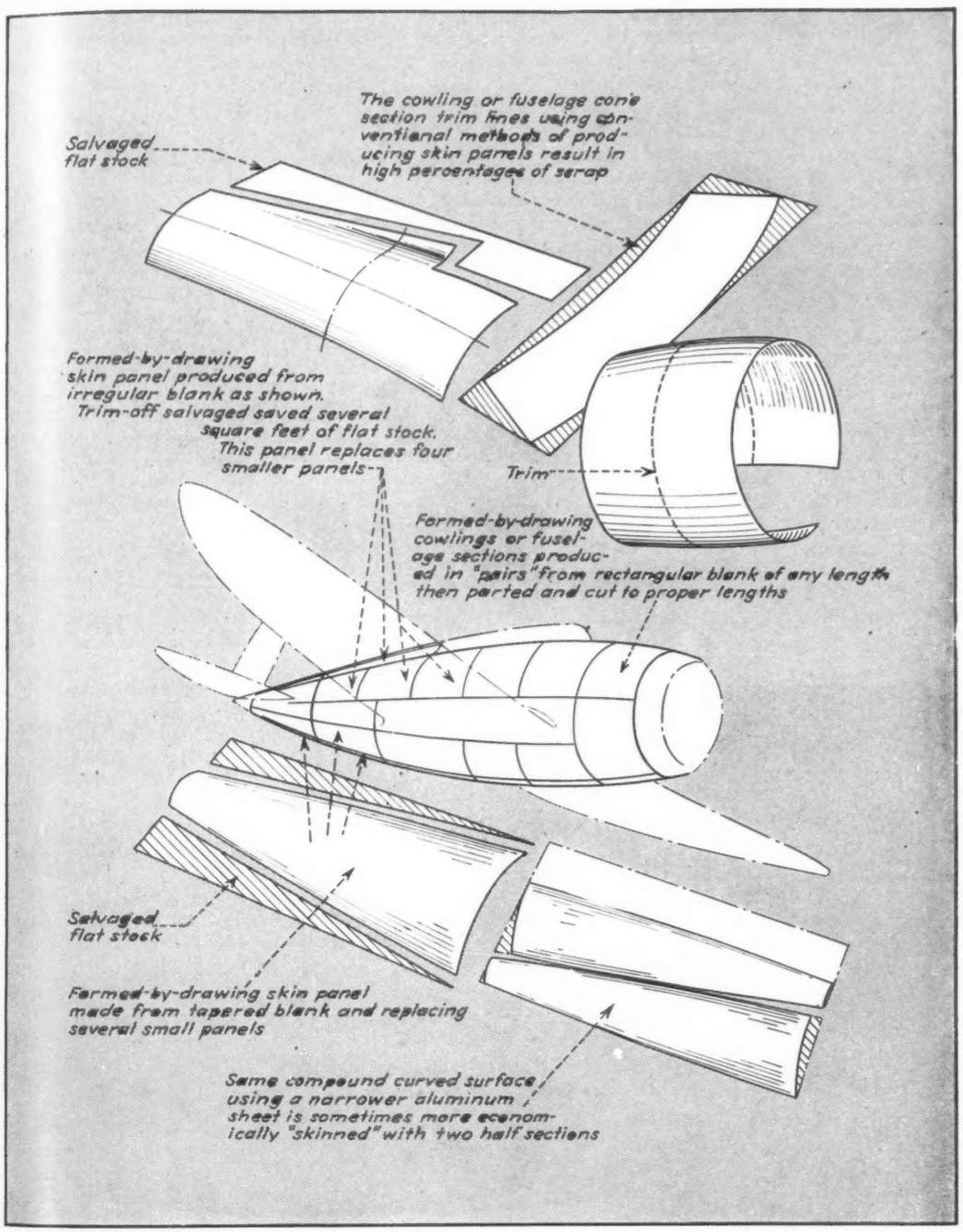
The cowling or fuselage cone section trim lines using conventional methods of producing skin panels result in high percentages of scrap
Salvaged flat stock
Formed-by-drawing skin panel produced from irregular blank as shown. Trim-off salvaged saved several square feet of flat stock. This panel replaces four smaller panels
Trim
Formed-by-drawing cowlings or fuselage sections produced in "pairs" from rectangular blank of any length then parted and cut to proper lengths
Salvaged flat stock
Formed-by-drawing skin panel made from tapered blank and replacing several small panels
Same compound curved surface using a narrower aluminum sheet is sometimes more economically "skinned" with two half sections

Typical fuselage showing reduction in number of skin panels possible by application of the Form-by-Drawing process.

making possible the "nesting" of blanks. Trim-off flat stock is utilized for smaller parts,

3. Ability to form sheets of unlimited dimensions making it possible to form duplicate or several dissimilar shapes in a single Forming-by-Drawing operation,

4. Tapering compound curved panels similar to cowlings requiring cone section blank developments can often be drawn in pairs from a rectangular sheet without waste from curved blank trim lines,

5. Forming of large panels eliminates joint footage, saving extra metal required at:

(*a*) lap joints,
(*b*) reinforcing strips, and
(*c*) trim-off scrap.

These are savings of metal related directly to the forming operation. Several other important, incidental material economies may also result as outlined in the following paragraphs:

A. Because of the extra metal required for gripping at the sides, conventional methods cannot form panels approaching or reaching the maximum width of stock sizes. When these conventional methods are used, it is necessary to change the design to narrower panels. The Forming-by-Drawing process can draw sheets of maximum stock size.

B. Physical tests and microphotographs of specimens treated by the Forming-by-Drawing method reveal no appreciable alteration in grain structure or reduction in thickness. By comparing physical characteristics, gage reductions and load tests on specimens formed by the various methods, it will soon be demonstrated that for equal strengths the Forming-by-Drawing process will make possible the use of lighter skin panel gages. Evidence of this important aluminum saving and weight reduction is also seen by the "dimpled" or punch countersunk rivet

holes free of cracks on 24ST even when the formed panel has been drawn at right angles to the grain of the metal.

C. The try-out periods of draw, Kirksite or drop hammer dies and stretch forms often consume quantities of sheet blanks—usually from a few to several dozens. The Anderson Forming-by-Drawing try-out consumption of aluminum sheets never amounts to more than three—often none. Most frequently several try-outs are made with but a single sheet which is finally re-drawn to correct shape and accepted.

D. On certain small subassemblies, such as bomb bay doors, where several small stretched skin panels with hand fitted joints are partially riveted and then spot welded, very often heat generated by the spot weld operation warps the surface area so that complete contact with the framework is impossible and a large percentage of small panels must be skillfully removed and replaced. (Waste of valuable skilled man-hours, as well!) A one-piece formed-by-drawing bomb bay skin panel provides a smooth continuous surface and prevents further scrapping of formed parts.

E. The elimination of a substantial number of skin panel joints made possible by the Forming-by-Drawing process, is accompanied by a very profitable reduction of rivets, thus, further saving aluminum as well as man-hours.

Formed-by-Drawing compound curved panels, as has been pointed out, are obtained with a minimum of local elongation. It is thus possible to form cold magnesium sheet metal, and for the aluminum alloys the heat treating operation is completely eliminated. Whenever the Anderson Forming-by-Drawing process is used aircraft design specifications are revised so as to replace SO materials with ST. The elimination of the expensive heat treating operation, needless to say, saves considerable amounts of materials, manpower and money and provides skin panels free of warpage which in turn will produce planes of higher performance.

The aerodynamicist strains in his relentless efforts to achieve aerodynamic efficiency, paying painstaking attention to the effects produced in drag by even so little as a coat of spray paint, or of fine grain sand collected on the polished skin surfaces. While he observes the drag at high speeds caused by sprinkling of minute particles on the skin surface of a pursuit plane, which may cost hundreds of horsepower, and in combat, perhaps the edge in speed to "whip" into firing position, aircraft constructors permit avoidable skin surface irregularities caused by improper forming, joints and rivets.

Aerodynamic efficiency has, in certain aircraft, been sacrificed as a compromise for lack of better production methods or facilities. Chief among the reasons for large lap or butt joint footages, is the lack of skin panel forming facilities. The cone section fuselage assembly made up of flat sheet cone segment developed blanks are laboriously strapped and riveted. The gradually changing slopes of the consecutive cone segments (the bases of which run normal to the line of flight) appear to, but actually do not form a continuous compound curved surface.

Another type of cone segment used is one having its axis parallel or approximately parallel to the center line of the fuselage. Although this type of skin panel has the advantage of using longer sections with fewer transverse joints, it nevertheless diverges from the more desirable form.

When flat sheets or imperfectly formed sheets are forced on the fuselage framework, the surplus of metal generally tends to manifest itself in the region surrounding the rivets in the form of smooth but raised surfaces above the theoretical skin surface which results in drag increases of considerable magnitude.

Small production runs of skin panels or even samples are economically produced by the Forming-by-Drawing process. Since there are only "adjustment" and "set-up" charges, but no tool costs, sample panels can be formed cheaply and long before dies for a conventional machine could be made.

Tool costs, therefore, do not exist. In the Anderson Forming-by-Drawing process tool "storage" for subsequent duplication of orders is merely a record card. In contrast, the other methods requiring tons of costly materials invested in dies, have a continuing overhead for the maintenance of die storage rooms or yards, with crane operators and maintenance crews.

The recognition of this advanced and revolutionary metal forming process and the increasing demand for its immediate application will make possible the installation of units throughout the country for more efficient production of planes of higher performance.

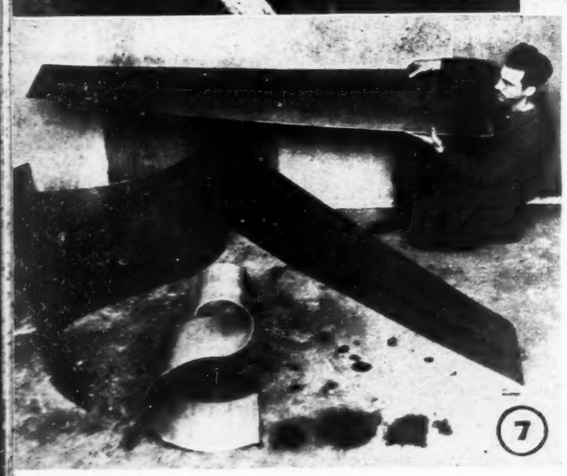

FIG. 5. Each panel fits on the checking fixture at all points. In the foreground is a stack of 50 panels of identical form before trimming off the ends.

FIG. 6. Shipping or storing of formed panels is easily accomplished by nesting. This compact crate contains 50 formed, untrimmed panels destined for Brewster.

FIG. 7. Stiffness of formed-by-drawing skin panels can be noted; one being held only at one end. Other panels represent variety of shapes obtained in a single stroke, each one having both transverse and longitudinal curvatures; some with points of inversion.

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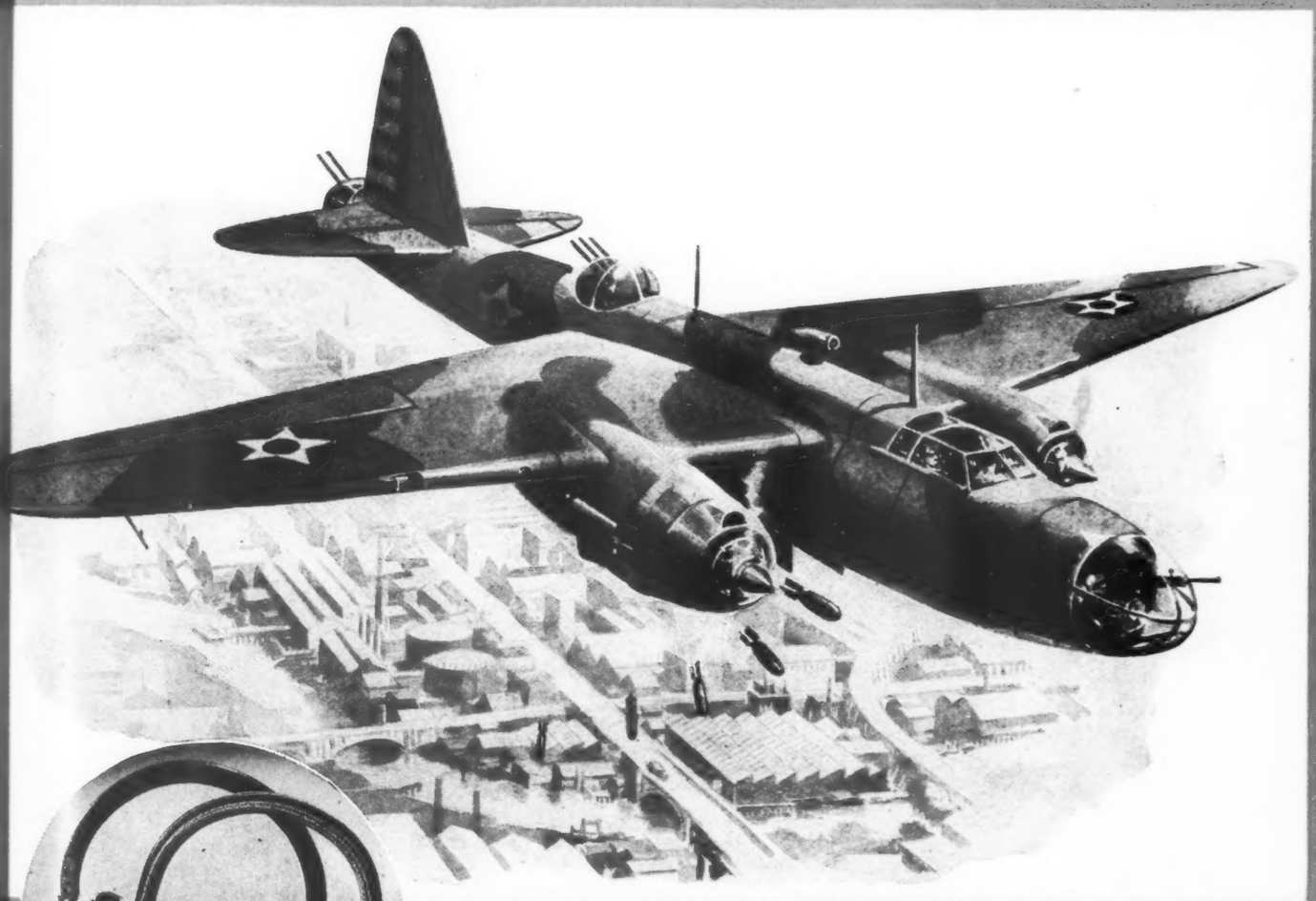

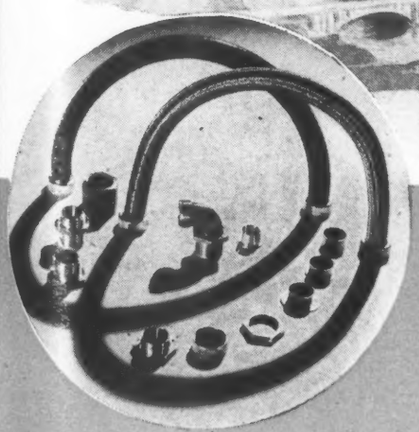

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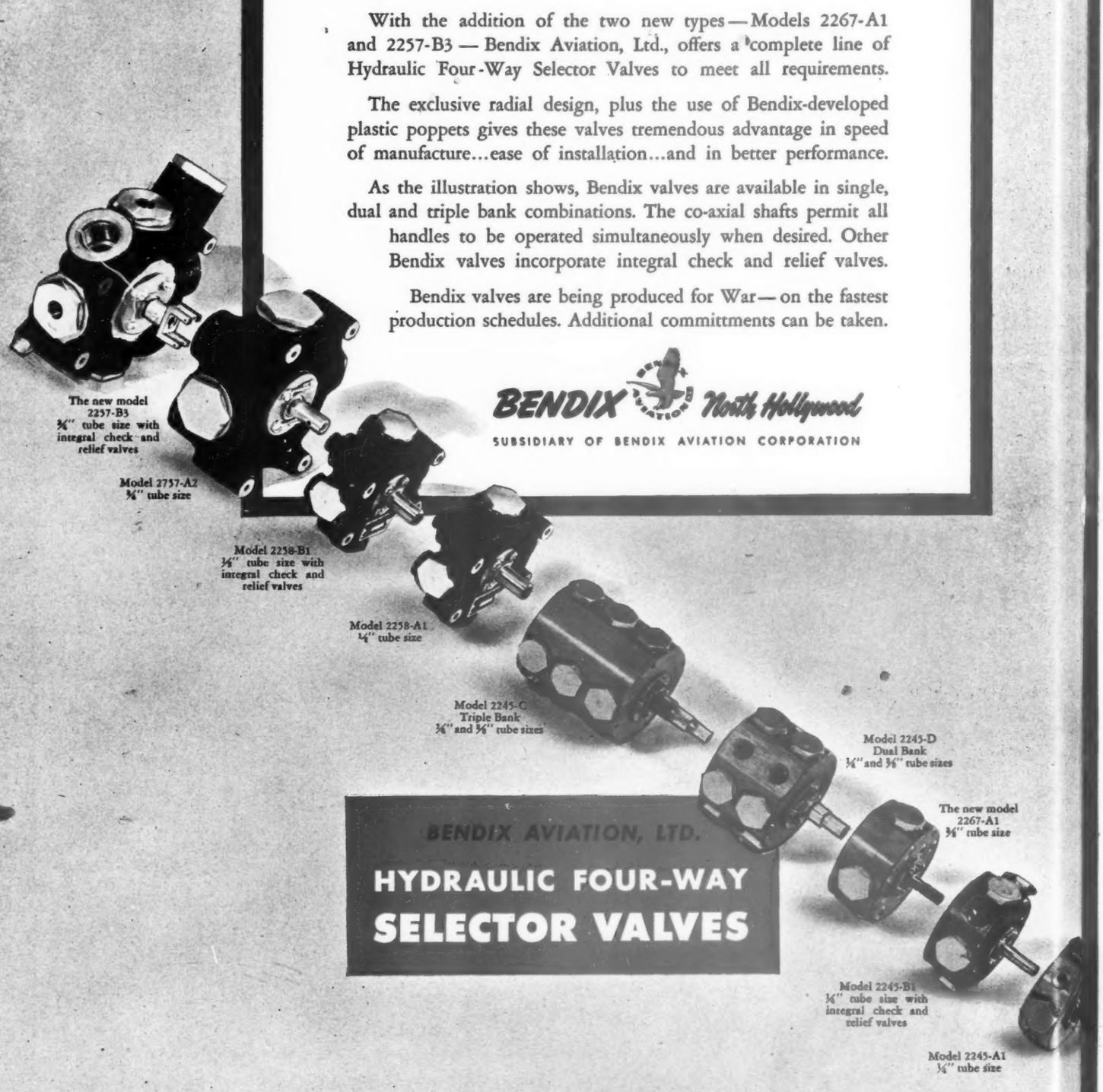
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Design Charts for Tubes Subjected To Axial Loads and Combined Stresses

By WALTER C. CLAYTON
Chief Engineer, Curtiss-Wright Technical Institute

IN TWO PREVIOUS articles appearing in the April and May issues of AVIATION, the writer presented design charts for tubular members subjected to bending and torsion. This, the concluding article of the series, contains a chart for tubular members subjected to axial loads; a chart for determining the weights of tubular members made of steel, aluminum alloy or magnesium alloy, and formulas for cases of combined loadings. The figure numbers and the equation numbers have been run consecutively, starting with the first article. The three figures appearing in this article are 9 to 11 inclusive.

The terminology used is the same as in the previous two articles with the following additions:

F_c = Allowable compressive stress (see Fig. 9).
k_w = Constant for determining weight of tube (see Fig. 11 and Eq. 18).
L' = Effective length of member.
P = Axial compressive or tensile load for which tube is being designed.
P' = Axial compressive or tensile load which tube selected is capable of resisting.
ρ = Radius of gyration of tube = approximately 0.34 D
R_s' = Stress ratio for bending including primary and secondary bending.
= Wall thickness for combined stresses.
t_b = Wall thickness for zero margin of safety in bending.
t_c = Wall thickness for zero margin of safety in compression.
t_s = Wall thickness for zero margin of safety in shear.
t_t = Wall thickness for zero margin of safety in tension.
W = Weight of tube in pounds.

Fig. 10 contains two curves for determining the compressive or tensile stresses in tubes subjected to axial loads. This chart is similar to those contained in the previous articles. The upper curve is used when it is desired to determine the wall thickness of a tube when the bore (inside diameter = d) has been decided upon. The lower curve is used when the outside diameter (D) has been decided upon. The ordinate scale at the left is non-dimensional and is in terms of

$$\frac{P}{D^2 F_{TU}}, \frac{P}{d^2 F_{TU}}, \frac{P}{D^2 F_c} \text{ or } \frac{P}{d^2 F_c}$$

depending on whether the axial load is one of tension or compression and whether the inside or outside diameter is being used. The allowable ultimate tensile stress, F_{TU}, does not vary with D/t nor does the allowable compressive stress for steel unless the value D/t is large enough to result in wall instability. Table 4-1 of ANC-5 states that it is not necessary to investigate for local instability for steel tubes having a D/t less than 50. The allowable compressive stress for steel may be obtained from Figs. 4-5 of ANC-5 which is reproduced here as Fig. 9. In order to determine the allowable column stress, the ratio of L'/ρ must be determined. Fortunately the radius of gyration does not vary appreciably with D/t and for our purpose may be considered to be 0.34 D.

The allowable compressive stress for Dural may be found from Figs. 5-1 of ANC-5.

It will be noted that the two curves of Fig. 10 approach one another as D/t increases. For large values of D/t the wall thickness can be computed with sufficient accuracy using the formulas:

$$t_c = \frac{P}{\pi D F_c} \quad (7)$$

or

$$t_t = \frac{P}{\pi D F_{TU}} \quad (8)$$

The use of Fig. 10 or Eq. (7) and (8) can be illustrated by an example.

EXAMPLE:

Given: A tube heat-treated to 180,000 psi. ultimate tensile strength, subjected to a compressive load of 75,000 lb. The length is 40 in. and it is desired to make the diameter 4 in.

Wanted: The required wall thickness for zero margin of safety.

Solution:

$$\rho = (0.34)\ (4'') = 1.36''$$

$$\frac{L'}{\rho} = \frac{40''}{1.36''} = 29.4$$

From Fig. 9: $F_c = 145{,}000$ psi.

$$\frac{P}{D^2 F_c} = \frac{75{,}000}{(4^2)\ (145{,}000)} = 0.0323$$

This value is not on the curve of Fig. 10, the value of D/t being greater than 80. We may therefore use the formula:

$$t_c = \frac{P}{\pi D F_c} = \frac{75{,}000}{(\pi)\ (4)\ (145{,}000)} = 0.041''$$

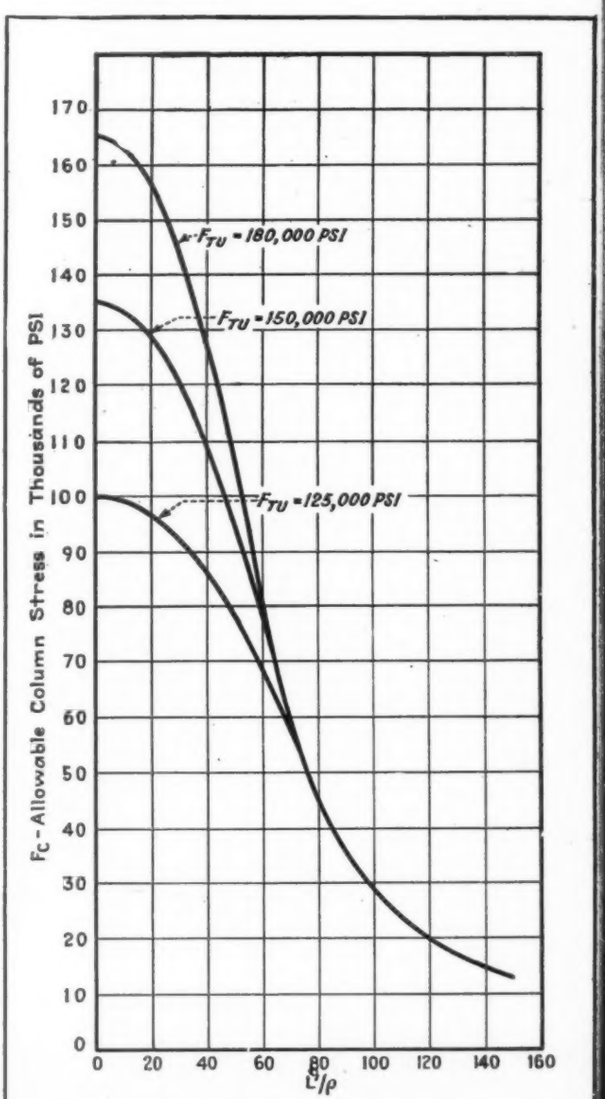
As the value of D/t exceeds 50 there is the possibility of buckling of the wall. A smaller tube diameter might therefore be used or an investigation made as per ANC-5 to make sure that the wall will not buckle locally. The above problem will be referred to later in problems of combined stresses.

Rarely is the designer fortunate enough to have to deal with only one type of stress at a time. A member designed for bending may in all likelihood also be subjected to torsion and possibly axial loads. The existence of one type of stress affects the load carrying capacity of a member as far as other types of stress are concerned. The Mohr's circle diagram or the equivalent equations are usable below the elastic limit and where buckling does not occur. For our purpose the stress ratio method serves better.

We may now consider the problem of combined stresses acting simultaneously. We will investigate the following:

1. Compression and bending.
2. Bending and shear.
3. Compression, bending and shear.

Fig. 9. Allowable column stress—heat treated alloy steel round tubing.



ANC-5 contains the stress ratio formulas for dealing with problems of combined stress. We find from ANC-5 the following relations for tubular members:

$$R_c + R_b = 1 \qquad (9)$$

This equation merely states that the stresses on the compressive side of a cylinder subjected to bending can be added directly to the compressive stresses due to an axial load, and that if a certain percentage of the allowable compressive stress exists, the remaining portion of 100 percent may be of allowable bending stress. Where bending and shear exist at the same time in a member the stresses cannot be added directly. In this case the relationship is:

$$R^2_b + R^2_s = 1 \qquad (10)$$

When the tube is subjected to compression, bending (including secondary bending due to column action) and torsion, the equation is:

$$R_c + R_b + R^2_s = 1 \qquad (11)$$

As pointed out in the first article, the stress ratio for bending may be expressed either as the ratio of the design fiber stress to the allowable fiber stress or the ratio of design bending moment to the allowable bending moment, hence:

$$R_b = \frac{f_b}{F_b} = \frac{\left(\frac{M}{D^3}\right)}{\left(\frac{M'}{D^3}\right)}$$

Thus, from Figs. 3, 4, 6, 7, 8, and 10 we may not only determine the wall thickness necessary for a tube of given material and diameter, but we may also determine the stress ratio for any given wall thickness, to be used in problems of combined stress.

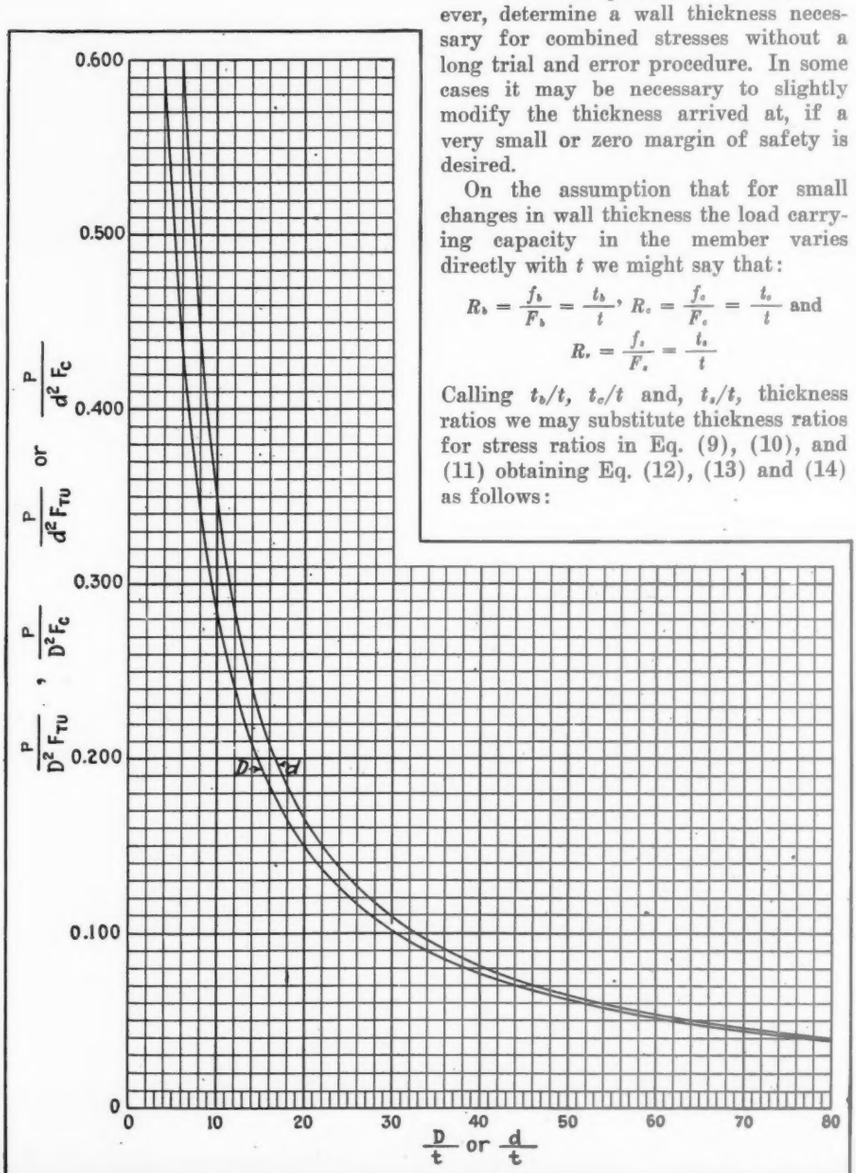
For very small changes in wall thickness the change in strength of a tube varies substantially as the change in wall thickness. If the wall thickness, however, is changed enough to appreciably effect the value of D/t, the allowable stress in the tubular member changes. While the wall thickness necessary to withstand a given amount of bending, torsion, or axial load, when dealt with separately may be obtained from the charts and equations of these three articles, the problem when they act simultaneously is somewhat more involved. The number of variables entering into the problem make a direct solution out of the question. We can, however, determine a wall thickness necessary for combined stresses without a long trial and error procedure. In some cases it may be necessary to slightly modify the thickness arrived at, if a very small or zero margin of safety is desired.

On the assumption that for small changes in wall thickness the load carrying capacity in the member varies directly with t we might say that:

$$R_b = \frac{f_b}{F_b} = \frac{t_b}{t},\ R_c = \frac{f_c}{F_c} = \frac{t_c}{t} \text{ and}$$

$$R_s = \frac{f_s}{F_s} = \frac{t_s}{t}$$

Calling t_b/t, t_c/t and, t_s/t, thickness ratios we may substitute thickness ratios for stress ratios in Eq. (9), (10), and (11) obtaining Eq. (12), (13) and (14) as follows:



Substituting in Eq. (9) we obtain the equation: $t_b/t + t_c/t = 1$ which may be reduced to:

$$t = t_b + t_c \qquad (12)$$

Substituting in Eq. (10) we obtain: $(t_b/t)^2 + (t_s/t)^2 = 1$ which may be reduced to:

$$t = \sqrt{t^2_b + t^2_s}. \qquad (13)$$

In the case of compression, bending and shear, we may substitute the thickness ratios in Eq. (11) thus: $(t_c/t) + (t_b/t) + (t_s/t)^2 = 1$. Solving this quadratic for t we obtain the equation:

$$t = \frac{t_c + t_b + \sqrt{(t_c + t_b)^2 + 4t_s^2}}{2} \qquad (14)$$

Just as Eq. (9), (10) and (11) were expressed in terms of "t" yielding Eq. (12), (13), and (14), they may also be transformed so as to yield margins of safety, becoming respectively, Eq. (15), (16), and (17). They are as follows:

$$(M.S.) = \frac{1}{R_b + R_c} - 1 \qquad (15)$$

$$(M.S.) = \sqrt{\frac{1}{R_b^2 + R_s^2}} - 1 \qquad (16)$$

$$(M.S.) = \frac{2}{R_c + R_b + \sqrt{(R_c + R_b)^2 + 4R_s^2}} - 1 \qquad (17)$$

The procedure of working problems of combined stresses can best be explained by means of examples. Taking the examples already given in the two previous articles and above in this article, we may find the wall thickness necessary for combined stresses.

EXAMPLES:

Given: An alloy steel tube 4 in. in diameter and 40 in. long, heat-treated to 180,000 psi. ultimate tensile strength.

(*a*) In the first article this tube was subjected to a bending moment of 250,000 in. lb. The value of $M/D^3 = 3910$ and $t_b = 0.112$ in.

(*b*) In the second article this tube was subjected to a torsional moment of 205,000 in. lb. The value of $T/D^3F_{TU} = 0.0178$ and $t_s = 0.097$ in.

(*c*) In this article this tube was subjected to a compressive load of 75,000 lb. The value of $P/D^2F_c = 0.0323$ and $t_c = 0.041$ in.

Wanted:

(*a*) The required wall thickness for the above bending and compression and a check on the margin of safety.

(*b*) The required wall thickness for the above bending and shear and a check on the margin of safety.

(*c*) The required wall thickness for the

Fig. 10. Chart for determining compressive or tensile stresses in tubes subjected to axial loads. The upper curve applies where inside diameters are used and the lower curve is for use with outside diameters.

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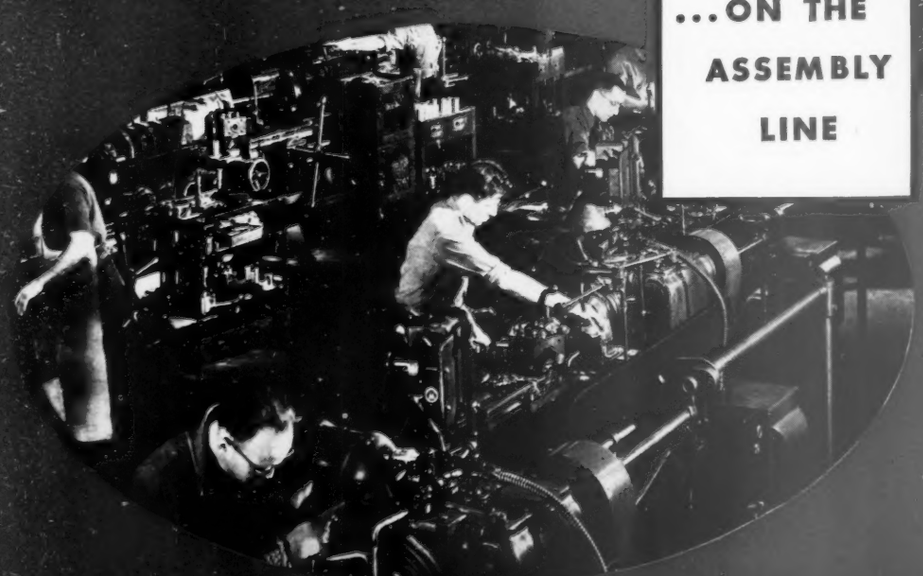

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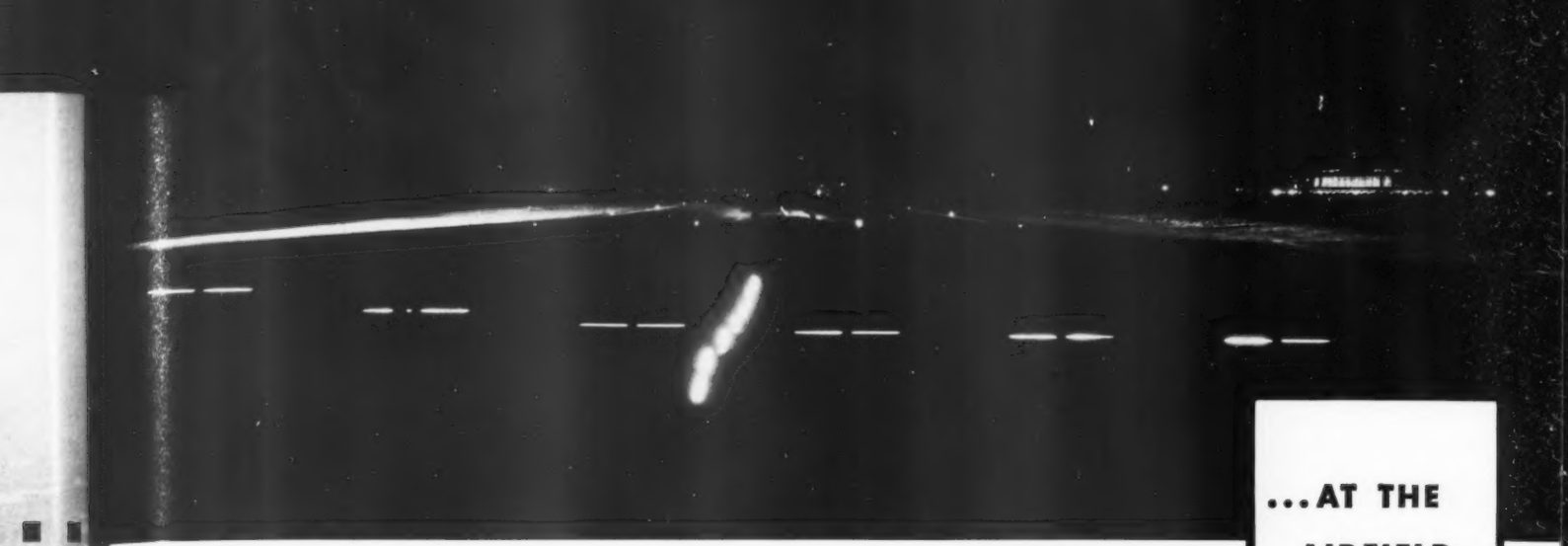

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Our entire experience and resources are at your service for any aviation problem. A call to our nearest Westinghouse office will bring you our immediate and full co-operation.

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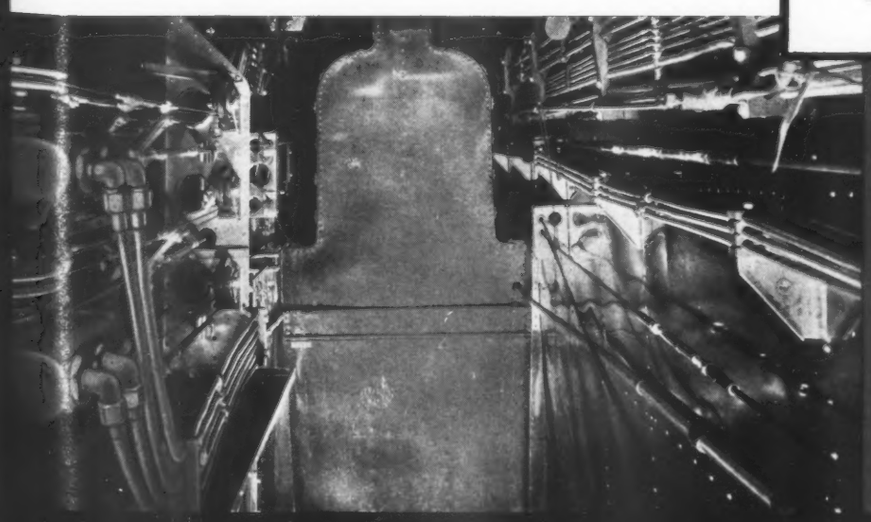
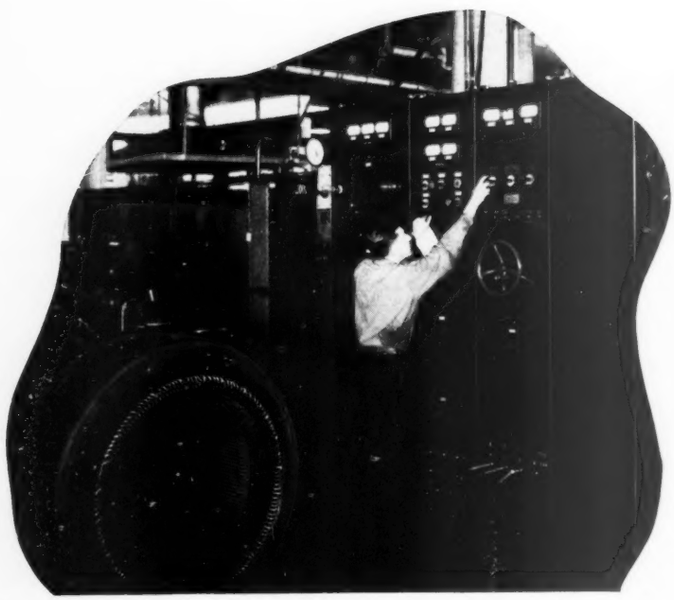
★ INSURES ACCURACY—Westinghouse electrical indicating instruments for aircraft (see above) and for aircraft plants have been developed for quick, easy reading and accuracy. Standardization in air-conditioned instrument testing laboratories assures full accordance with government specifications. Write for illustrated booklet, B-3073.

★ SAVES WEIGHT—Hundreds of thousands of Westinghouse Micarta control pulley wheels are being used in modern aircraft, because they are lightweight and strong . . . reduce control cable wear. Because of light weight and strength, Westinghouse Micarta is used in over 25 pieces in modern aircraft, including fair-leads, bushings and instrument boards.



and to keep your equipment operating . . .



4 WESTINGHOUSE SERVICES

★ **FIRST:** To speed renewal parts to you, Westinghouse has established 17 warehouses in or near leading aviation centers. Stocks on hand include those parts normally subjected to the most wear or burning such as contact tips, shunts, coils and bearings. When your own emergency stock of renewal parts runs low, order direct from our local office.

★ **SECOND:** To facilitate major repair work, Westinghouse has established 34 district manufacturing and repair plants. Each of these plants is equipped to repair, remodel or recondition electrical apparatus. More than 4,000 employes are now serving our customers from these district plants alone. Call our local office to save time on repair service.

★ **THIRD:** To help you with the problem of getting more out of your present equipment or in consideration of a change to save time and speed production, Westinghouse maintains a staff of experienced engineers at every Westinghouse office. These men are constantly working with plant and aviation engineers in every phase of the industry. Many of the problems thus solved may provide a quick answer to a similar problem of yours. Use this service the next time a problem arises.

★ **FOURTH:** Westinghouse has prepared a valuable book "Maintenance Hints" which gives you helpful suggestions on the care of electrical equipment . . . including ways to make it last longer and give you better service. "Maintenance Hints" is free. See that each of your maintenance men gets a copy. Just fill in the attached coupon and mail it today.

★ ★ ★ ★ ★ ★ ★ ★ ★

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TIME-SAVER FOR THE AVIATION INDUSTR

above compression, bending and shear and a check on the margin of safety.

Solution:

(*a*)

$$t = t_b + t_c = 0.112'' + 0.041'' = 0.153''$$

$$\frac{D}{t} = \frac{4''}{0.153''} = 26.2 \text{ (From Figs. 3 and 10:}$$

$$\left(\frac{M'}{D^3}\right) = 5450, \frac{P'}{D^2F_c} = 0.115 \quad \text{Then:}$$

$$R_b = \frac{3910}{5450} = 0.717, \qquad R_c = \frac{0.0323}{0.1150} = 0.281$$

$$(M.S.) = \frac{1}{R_b + R_c} - 1 = \frac{1}{0.717 - .281} - 1 = + 0.02\%$$

(*b*)

$$t = \sqrt{t_b^2 + t_c^2} = \sqrt{0.112^2 + 0.097^2} = 0.148''$$

$$\frac{D}{t} = \frac{4''}{0.148''} = 27.0 \quad \text{(From Figs 3 and 6:)}$$

$$\left(\frac{M'}{D^3}\right) = 5250, \qquad \frac{T'}{D^3F_{TU}} = 0.0298 \quad \text{Then:}$$

$$R_b = \frac{3910}{5250} = 0.744, \quad R_c = \frac{0.0178}{0.0298} = 0.597$$

$$(M.S.) = \frac{1}{\sqrt{R_b^2 + R_c^2}} - 1 = \frac{1}{\sqrt{0.744^2 + 0.597^2}} - 1 = + 4.8\%$$

(*c*)

$$t = \frac{t_c + t_b + \sqrt{(t_c + t_b)^2 + 4t_c^2}}{2}$$

$$t = \tfrac{1}{2}(0.041 + 0.112) + \tfrac{1}{2}(\sqrt{(0.041 + 0.112)^2 + 4(0.097)^2} = 0.200''$$

$$\frac{D}{t} = \frac{4''}{0.200''} = 20.0 \text{ (From Figs. 10, 3, 6:)}$$

$$\frac{P'}{D^2F_c} = 0.1490, \frac{M'}{D^3} = 7260, \frac{T'}{D^3F_{TU}} = 0.0415$$

Then:

$$R_c = \frac{0.0323}{0.1490} = 0.217, \; R_b = \frac{3910}{7260} = 0.538, \; R_s = \frac{0.0178}{0.0415} = 0.429$$

$$(M.S.) = \frac{2}{R_c + R_b + \sqrt{(R_c + R_b)^2 + 4R_s}} - 1 = + 5.5\%$$

As pointed out above, the value of thickness thus obtained for combined stresses will not usually yield a zero margin of safety due to the fact that the allowable stresses in bending and in shear have been altered somewhat by the change in D/t, making it necessary to check back to determine the true margin of safety. The discrepancy will be a maximum when the values of t_b, t_c and t_s are approximately equal. Where one is appreciably larger than the others, the change in thickness will be relatively smaller and the margin of safety generally close to zero.

When the wall thickness is increased by retaining the outside diameter and reducing the inside diameter, as in the examples above, the material added is being placed where it is least effective (on the inside of the tube). This is more or less compensated for by the fact that the allowable stresses for bending and shear increase as the wall is thickened. When the wall thickness is increased by maintaining the bore of the tube and adding the material to the outside of the tube, the material is being placed where it is most effective, and the allowable stresses are increased because of the decrease in D/t. Thus there will generally be positive margins of safety in such cases of greater magnitude than in the examples above. If the tubular members are of the heavy wall variety, (small D/t ratio), the margins of safety will deviate still further from zero.

A tube subjected to torsion, having a tendency to fail through buckling of the wall, will have this tendency accentuated by the addition of compressive stresses. On the other hand, this buckling tendency is reduced by tensile stresses. This is covered in Fig. 255, Theory of Elastic Stability by Timoshenko*.

A chart (Fig. 11) has been added to facilitate weight estimation. Knowing either the inside or outside diameter of the tube and the wall thickness, also the length of the member and the material from which it is made, it is readily possible to determine the weight of the member. Fig. 11 gives three curves, for steel, aluminum alloy and magnesium alloy. The curves are plotted with k_w as ordinates and D/t as abscissa. Knowing the D/t of the tube, a line can be drawn from the D/t scale to the curve representing the material used, thence horizontally to the k_w scale. The weight in pounds is obtained from the equation:

$$W = (k_w)\,(L)\,(D^2) \qquad (18)$$

EXAMPLE:

Given: Steel tube, $D = 4''$ $t = 0.200$ $L = 40''$

Wanted: Weight in pounds

Solution: $D \div t = 4'' \div 0.200'' = 20$

From Fig. 11, $k_w = 0.0425$

Then: $W = (0.0425)\,(40)\,(4^2) = 27.2$ lb.

In conclusion the writer wishes to thank Mr. George Bauer and Mr. Carl Gelin of the Curtiss-Wright Technical Institute staff for their assistance.

* McGraw-Hill Book Co.

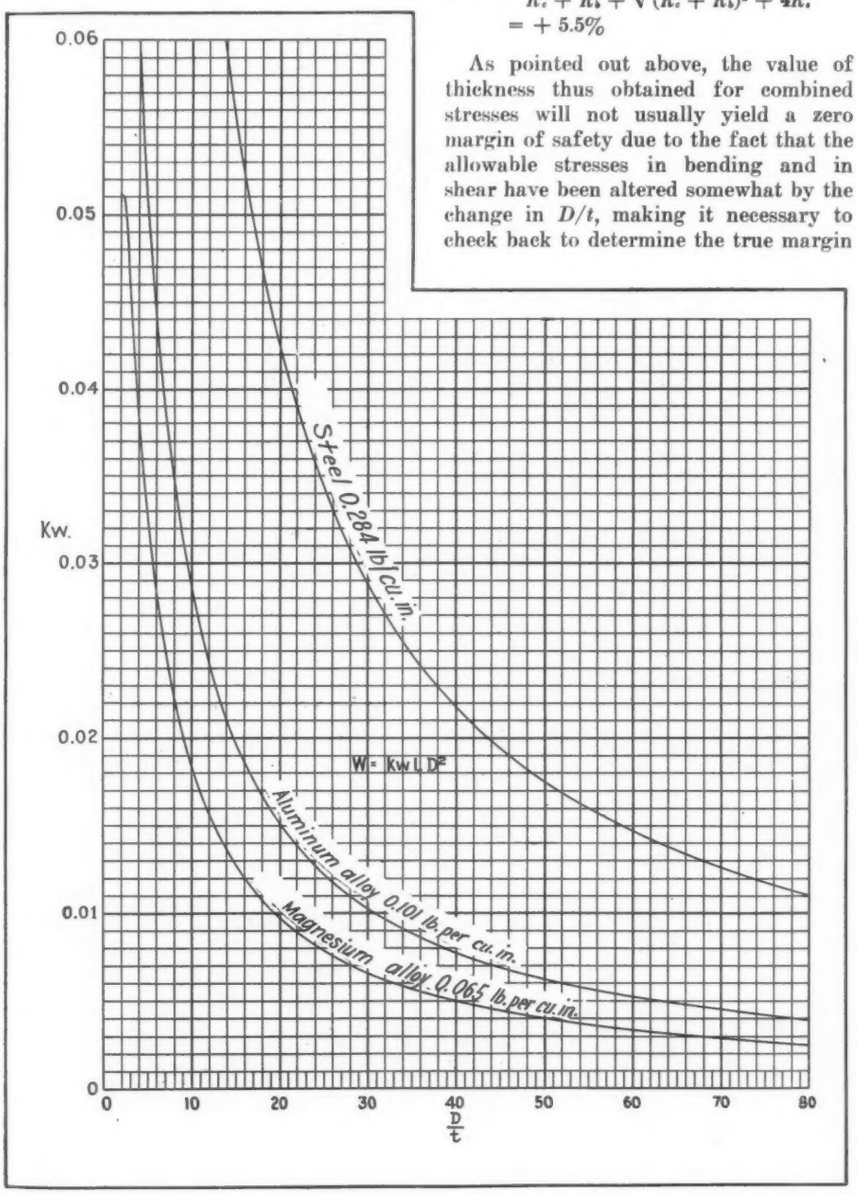

Fig. 11. Chart for estimating the weight of tubular members of known dimension and material.

1. *Mass production of propeller blades from seamless steel tubing gets under way at dedication of American Propeller Corp's., new plant "somewhere in the midwest." William F. Wise, president, outlines to Brig.-Gen. A. W. Vanaman, Commanding General, Wright Field, and Brig.-Gen. K. B. Wolfe, Army Air Forces production division head, how the tubing is transformed to blades by a series of hot forging, cold pressing, machining and welding operations. From bottom to top are: tubing as it comes from the mills; precision honed and ground tube; swaged, upset and polished tube; bent and flattened tube; formed and welded blade; and finished product.*

New Mass Production Methods For Propellers

2. *Here a tube is being set in one of a battery of four huge swaging presses which, with a weight of more than 250 tons, are said to be the largest mechanical presses ever built.*

3. *A swaged tube goes into a forging machine for one of the processes of conversion from steel tubing to propeller at one of the largest blade plants in the United States.*

4. *Nearing the end of the mass production line, the propeller blade, filled with gas to insure proper shaping, is formed on a giant press. These blades are the first to be made of a special chrom-molybdenum alloy which, although very difficult to work, gives the propeller improved physical properties, increased fatigue strength and, in the larger sizes, lighter weight than aluminum.*

5. *The final—and feminine—touch, as a finished blade is checked through one of the inspection stations in a plant started only last fall and put into operation weeks ahead of schedule.*

BEHIND every "happy landing" is the accurate strength-weight factor engineers have established for vital plane parts. Not the least of these parts is the axle.

For the axles of many fighter and bomber aircraft, tubing is supplied to manufacturers by Ohio Seamless. To meet rigid Army and Navy specifications, this tubing must be free from scale, pitting, seams, tears and such physical defects.

Ohio Seamless tubing "carries the load" in many important airplane parts. With its uniformity of strength, wall thickness, O.D. and I.D. diameters, size, hardness and machinability, it "delivers" wherever exacting requirements are demanded in the manufacture of today's finest fighting planes.

Above: Semi-processed section of Ohio Seamless tubing supplied for the axle of one of America's foremost fighting machines. When heat-treated, such tubing obtains physicals as high as 200,000 psi. ultimate strength.

THE OHIO SEAMLESS TUBE COMPANY

SHELBY, OHIO

OHIO SPECIAL QUALITY

Speeding Production By Automatic Welding

"Speed and more speed" is the motto of the war industries, and new and better methods of fabrication supply the answer. This is particularly true in the aircraft industry, where the virtues of arc welding, particularly by means of the automatic arc welding head, are being increasingly recognized.

A good example of an application of the automatic welding machine to high-speed war production is offered by subcontractors of the Boeing Aircraft Company, Seattle, Wash., who produce aluminum gas tanks of the bullet proof type for the great *Flying Fortresses* at high speed by means of automatic welding equipment supplied by The Lincoln Electric Co., Cleveland, Ohio.

Engineers for the company find that use of the "Electronic Tornado", as the device is called, results in four distinct advantages: (1) Increased speed of welding; (2) lack of distortion; (3) uniform high quality welds; and (4) lower cost of welding.

Welding with the automatic head, illustrated in the photographs, now is done six times as fast as it was by the manually-operated carbon arc.

Fig. 1 shows a welder adjusting the automatic welding head prior to welding a seam. This shows a good side view of one of the aluminum tanks "A" on the holding jig. The numerous square objects visible in this picture are "hold-down" bars "B" used to position the work.

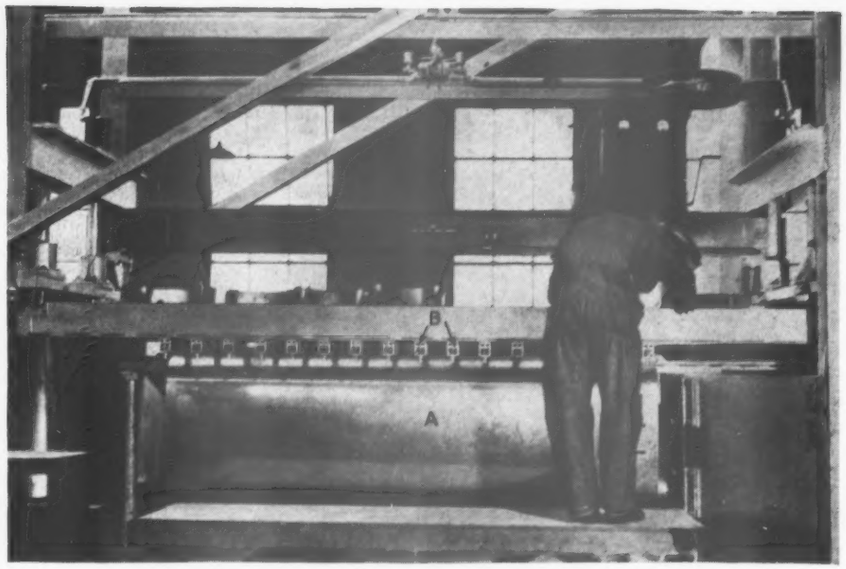

FIG. 1. Production of bullet proof aluminum gas tanks for "Flying Fortresses" by automatic arc welding at the plant of a subcontractor for Boeing Aircraft Co. The operator is adjusting the automatic welding head prior to welding seam.

An end view of the same set-up is illustrated in Fig. 2. These tanks are made in two halves of $\frac{1}{8}$ in. aluminum, butt welded over a relieved copper back-up bar. A $\frac{3}{8}$ in. Tornado boot holds the carbon in this application, a special Lincoln aluminum flux is applied automatically and filler wire automatically feeds into the seam as the welding progresses.

When the weld on one side is completed, the tank shell is removed from the jig, turned over and the opposite weld is made. After these two automatic welds are made, one head of the tank shell is inserted and manually welded on the edges. For this purpose $\frac{3}{32}$ in. Aluminweld electrode, manufactured expressly for welding aluminum, is employed.

All of the welds are cleaned with steam and hot water under pressure and with a wire brush. The welds then are neutralized in a pickling tank to relieve any stresses.

Fig. 3 shows one of the longitudinal seams being welded automatically.

The other head, or end piece, is bolted in place to permit insertion or replacement of the rubber bag which renders the tank bullet proof. This gasoline bag is secured to the inside of the tank by means of straps which come through the tank at various points for support.

FIG. 2. End view of the automatic welding set-up used in production of bullet proof aluminum gas tanks.

Hot Weather Brings Need For More Salt

Advent of hot weather, coupled with expansion of the aircraft industry to areas of high temperatures and addition of thousands of new workers brings renewed need for education in the value

FIG. 3. Automatic welding of longitudinal seam in production of bullet proof aluminum gas tanks.

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Army of Skilled Craftswomen Grows

Members of swiftly growing army of women aircraft workers invading what once was strictly man's domain are these skilled craftswomen at Wright Aeronautical Corp's., Paterson, N. J., plant. Clad in blue slacks and blouses with close fitting caps to keep wisps of hair out of machinery, women today turn out crankshafts, cylinder heads and barrels, gears, crankcases, propeller shafts and other parts. They include housewives, former school teachers, shop girls, waitresses, stenographers, textile workers, farm girls—even grandmothers who operate turret lathes, drill presses, milling machines, grinders and huge multiple operation combination machines. Above left, two-man operator uses plug gauge to check accuracy of holes drilled in cylinder head as it emerges from 154-ft. transfer machine for drilling, reaming and tapping. The largest machine tool used in aircraft engine industry, it is operated entirely by women. Upper right, feminine operator grinds thread on cylinder barrel, working side by side with men, drawing a man's pay. Lower right, former silk mill weaver operates horizontal milling machine, processing a part for Cyclone engine. Women are particularly skillful in precision work.

of salt as one means of maintaining health and efficiency, medical authorities warn.

Explaining that salt losses must be replaced daily to prevent heat sickness or even cramps, they point out that the unnoticed cases are most dangerous, for even a slight lack of salt-balance saps energy and slows up muscular coordination and reactions. Recent studies show the average person can maintain proper balance from the salt used in food seasoning, but workers engaged in heavy work or long hours need added quantities.

Industrial physicians agree, one study declares, that the average worker needs one level teaspoon of salt for each gallon of water. Since even those on the hottest jobs seldom drink more than two gallons of water in an eight hour day, the extra quota required is about two level teaspoons, about 60 percent above the average diet.

Development of salt tablets has proven of material aid in many plants when accompanied by proper employee education, this study points out. Workers engaged in light to medium work, it notes, require from four to six of the ten-grain tablets—about the same size as aspirin—those in medium to heavy work from 8 to 10 tablets; and those engaged in extra heavy, hot work need from 12 to 15 tablets in an eight hour day.

19 PLACES TO GET A 50% SAVING IN ASSEMBLY TIME

To back up your industry with a continuously plentiful supply of one of your most-in-demand items, a total of 19 screw manufacturers have been equipped to produce time saving, trouble-saving Phillips Recessed Head Screws.

Tremendous manufacturing capacity . . . nationwide distribution . . . are augmented by a corps of 150 sales engineers, qualified to help you get the most from Phillips. In the average case, they can show you how to save 50% in assembly time — eliminate operations, prevent accidents, eliminate burrs, get stronger fastenings.

The shape, taper and depth of the Phillips recess were determined after thousands of tests. The drivers maximum turning power is utilized without sacrifice of strength in the screw head . . . without danger of shearing the metal or breaking the bit. That's why the majority of units turned out by leading aviation and automotive concerns are Phillips-assembled.

Phillips Recessed Head Screws

WOOD SCREWS • MACHINE SCREWS • SHEET METAL SCREWS • STOVE BOLTS • SPECIAL THREAD-CUTTING SCREWS • SCREWS WITH LOCK WASHERS

U. S. Patents on Product and Methods Nos. 2,046,343; 2,046,837; 2,046,839; 2,046,840; 2,082,085; 2,084,078; 2,084,079; 2,090,338. Other Domestic and Foreign Patents Allowed and Pending.

Order stronger, cost-cutting Phillips from any of these sources

19 SOURCES of SUPPLY

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N.H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N.Y.
Pawtucket Screw Co., Pawtucket, R.I.
Pheoll Manufacturing Co., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N.H.

Aviation Priority And Allocation Orders

HERE is a compilation of substantially all of the priority, allocation and other control orders issued by the government, affecting airplane manufacture and maintenance, since the defense program started. Some of these War Production Board orders have been carried along from the beginning, through National Defense Commission, the Supply Priorities and Allocations Board, and Office of Production Management. In making this summary, AVIATION has had reference to the *New York Journal of Commerce* compendium of price and priority regulations.

Airframes—On June 26, 1941, WPB gave materials entering the production of airframes for heavy bombers a preference order P-9; aircraft engines for heavy bombers, P-9-b; propellers for heavy bombers, P-9-c; gun turrets for heavy bombers, P-9-d; gun fire controls and airsights, P-9-e; and turbosuperchargers for heavy bombers, P-9-f.

Airframes—On July 3, 1941, WPB in preference order P-13 assigned high rating to materials going into production of airframes for models SB-2-c and SO-3-c.

Repair Parts—On July 21, 1941, OPM assigned A-10 preference rating to 27 producers of aircraft and aircraft items to step up delivery on materials for repair parts and for new planes used for pilot training, home guard units, pipe line patrol and other specified purposes.

Commercial Aircraft Upkeep—On September 6, 1941, WPB issued a blanket A-3 priority rating to cover deliveries of equipment needed for commercial aircraft upkeep or ground equipment; ratings to cover three-month periods, can be re-extended. Form PD-96 should be used for applications.

Repair of Air Transportation—Preference rating, P-47, was issued September 6, 1941, by WPB for material entering into the maintenance and repair of air transportation facilities.

Aircraft Accessories—Materials going into the production of aircraft accessories have a preference rating of P-52, issued September 15, 1941, by WPB.

Airframe and Aviation Engines—Preference orders P-3 and P-4 were issued giving assistance to manufacturers of airframe and aviation engines, have been extended to December 31, 1941.

Civilian-operated Planes—On October 27, 1941, WPB amended preference rating order P-6-a giving A-10 rating to deliveries of necessary repair parts and accessories for all registered and certificated civilian-operated planes, to cover deliveries to dealers supplying operators.

Materials for Planes—On December 31, 1941, OPM granted one month extension on priority assistance in obtaining materials for airplanes, airplane engines and equipment, electrical relays and solenoid assemblies, radio receiving, transmitting and directional equipment. New order being prepared to replace those now extended.

Planes, Engines, Equipment—On January 19, 1942, WPB extended to March 31 the preference rating orders granting priority assistance in obtaining materials for production of planes, engines, equipment, etc. It covers P-3, P-4, P-9-a, P-9-b, P-9-c, P-9-d, P-9-e, P-9-f, P-9-g, P-13, P-15 and P-16.

Airline Equipment—In airline operation equipment order, P-47, interpretation No. 1, issued February 12, 1942, WPB stated ratings may be applied to maintenance and ground equipment, as well as to materials actually incorporated in planes.

Planes—On February 20, 1942, preference order P-109 formalizes A-1-a rating for planes, and replaces twelve orders previously applied to the industry.

Commercial Airlines—On March 6, 1942, materials for commercial airlines were given a limited blanket preference rating of A-1-j; the old A-3 rating changes by WPB in the first amendment to order P-47.

Military & Navy Aircraft—On March 11, 1942, WPB acted to extend assignment of higher preference ratings to deliveries for military and naval planes. Preference rating order P-122 raises to A-1 or A-1-b ratings assigned by any previously issued preference rating certificate for such aircraft.

Aircraft Products—Distinction is abolished March 12, 1942, between materials used in aircraft products and necessary material used by companies producing aircraft. WPB's amendment to preference rating order P-109 permits application of same ratings to purchase orders previously placed.

Material Suppliers—Under Amendment No. 1 to P-109, aircraft material suppliers may apply an A-1-a rating for those operating materials absolutely necessary in processing the aircraft parts which they furnish on ratings assigned on the order.

PRODUCTION MERRY-GO-ROUND

Rotary table feed designed by Lockheed engineers for 250-ton single-action hydro-press, with which less than a dozen men handle more than 20,000 parts in 8-hr. shift, compared with old-fashioned method using 2,500 and 4,000 ton presses with which 20 men could handle only 12,000 parts in same time. Each "feeder" places one or more small parts on die as it wheels in front of him, then table moves on a notch until all dies and parts they are to form are in place under press hoof. This machine, costing about one-third as much as older presses, fabricates small parts for both P-38 and Hudsons.

★ The production of large and intricate aluminum castings is dependent upon the right type of molding machines and handling equipment that can service correctly the individual type of castings involved. National has these facilities and in addition, our personnel is especially adapted to, and thoroughly experienced in, the making of this type of casting. ★ The above has been one of the prime factors in making National one of the greatest producers of large aluminum castings in production quantities.
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GE vertical cylindrical electric furnaces for heat treating tubular-shaped parts, consisting of two hardening and two drawing furnaces, oil quench tank, two jib hoists with transfer hoods and protective atmosphere equipment. Furnaces have 30-in. inside diameter, and are suitable for parts 60 in. long.

Heat-Treated Parts for Lockheed Interceptors

Tubular parts for the speedy Lockheed P-38 Intercepter planes now being turned out for use both by this country and Great Britain are produced in record time by a subcontractor. Since these vital parts must be both elastic and tough to withstand the strain of lightning-like interceptor movements, careful heat treating is essential.

To accomplish this job in step with today's high-geared production, four General Electric cylindrical electric furnaces for hardening and drawing, and a water-cooled oil quench are used. Two G-E atmosphere gas converters maintain an inert atmosphere in the furnaces, and assure that the analysis of gas in the furnaces is constant regardless of changes in the rate of flow.

Heretofore, one of the greatest difficulties in hardening and drawing tubular parts has been excessive cooling encountered in transferring the parts from the furnace to the quench tank. This difficulty has been overcome by installing two quenching hoods on the GE hardening furnaces to protect the parts as they are transferred.

This transfer of parts is accomplished quite simply. After the charge is brought up to the proper temperature in the hardening furnace, a high-speed hoist, equipped with a transfer hood is brought over the furnace and the charge quickly pulled into the transfer hood. The hood is then positioned over the oil quench tank and the charge quickly dropped into the oil. This transfer hood minimizes cooling, warpage and scaling of the thin-wall tubular parts during transfer from the furnace to the oil quench tank.

REVIEW OF PATENTS

By ELTON H. BROWN, JR., *Patent Agent*

Following are digests of the more significant of recent patents on aviation developments announced by the U. S. Patent Office:

Airplane, 2,284,519. R. F. Hall, assignor to Bell Aircraft Corp., Buffalo, N. Y. A multiple part wing flap arrangement which is adapted to assume varied positions for increasing the lift during short take-off and landing time.

High glide aircraft, 2,284,984. F. Nixon et al, assignor to Bristol Aeroplane Co., Ltd. Cabin pressure maintaining system for high altitude flying.

Airplane equipment to heat the wings, 2,285,071. F. J. Wolff, Trenton, N. J. Means for collecting air which has been heated by passing over the motor and distributing it through the wings heating them to prevent icing up.

Automatic banking means for airplane gyro pilots, 2,285,754. W. A. Matthews, assignor to Sperry Gyroscope Co., Inc., Brooklyn, N. Y. An automatic compensating banking device which will give the exact bank angle for any degree of turn.

Multiple motor drive for aircraft propellers, 2,284,473. A. S. Menasco et al, assignor to Vega Aircraft Corp., Burbank, Calif. An arrangement for driving a propeller at a constant speed by two or more motors and maintaining the speed, even if a motor of the group stops or slows down.

Airplane wheel, 2,282,359. C. Hollerith, assignor to Hayes Industries, Inc., Jackson, Mich. A sealed braking wheel for amphibian ships which has vent means to maintain an equalized pressure on the inside of the wheel.

Airplane pick-up and delivery apparatus, 2,282,920 and 2,282,921. T. S. Adams, assignor to All American Aviation, Inc., Wilmington, Del. Mechanism for releasing bundles from planes at a predetermined time by having a hook from the ship catch on a bar on the ground and actuate a trigger on the ship releasing the bundle. Also mechanism for picking up a bundle by means of a special grapple arrangement.

Means for dumping fuel from an aircraft. 2,283,502. H. R. Hughes et al, assignor to Hughes Tool Co., Houston, Tex. An arrangement to dump fuel sufficiently clear of the ship so that none of the fuel or vapors will seep into the ship or adhere to the surface and cause explosions and fire.

Anti-hunting automatic pilot, 2,283,733. W. M. Harcum, assignor to Sperry Gyroscope Co., Inc., Brooklyn, N. Y. A dual operator arrangement for controlling the servo motors of an automatic pilot in which one operator damps out oscillations of the ship and prevents "hunting" in the automatic pilot.

2,000 Alien Patents Seized by United States

The Alien Property Custodian at this writing had confiscated approximately 2,000 patents and patent applications, quite a few of which are directly related to the aeronautical industry. The German firms of Junkers and Arado and the Italian firm Caproni had many of their patents seized.

Patents under the jurisdiction of the Alien Property Custodian may be licensed to manufacturers in the United States, and it is the purpose of the Alien Property Custodian to promote use of the inventions contained therein to improve our products particularly with relation to the war effort.

Manufacturers interested in obtaining licenses under enemy alien owned patents can apply for licenses by writing to The Alien Property Custodian, Washington, D. C.

It is suggested that if the manufacturers will furnish the following information in their first letter, their request can be more efficiently handled.

A. Identify the patent, listing the inventor's name, patent number and date.

B. A statement to the effect that from the records of the United States Patent Office, the title of the patent appears to be in the name of an enemy alien.

C. Prepare a statement of ownership for the company, including the names of the principal stockholders.

D. Prepare a general description of the company including such things as general financial status, type of business or manufacturing now being conducted.

E. Statement as to the use the articles manufactured under the present patent will be put. Relationship they will have to the war effort including priority rating which can be obtained to practice the invention.

F. Statement of the facilities and capital available for practicing the invention.

G. Give facts concerning all previous use the manufacturer has made of the invention covered by the patent.

No official set of questions or mode of procedure has been developed by the Alien Property Custodian. It appears, however, that the above material is information which will be helpful in expediting each case. There may be other problems to be worked out after the foregoing information has been furnished.

THREE OFFERS AND A PROPOSAL

IMAGINEERING

SO MUCH SO SOON

FIRST OFFER: If you operate *any kind* of equipment made of aluminum and you are baffled in any way in maintaining it in top condition—give us the facts, and we will rush you our recommendations.

We are busy making more millions of pounds a month than we made in a whole year, not so long ago—but not too busy to make sure that no single pound of aluminum at work anywhere on war effort shall fail to do its share of making whatever it takes to win.

SECOND OFFER: If you are making anything whatsoever out of aluminum, and are stumped in any way in setting up the best methods of fabricating it—give us the facts, and we will see that you get all the know-how in our power.

THIRD OFFER: If you have joined the host of those who believe that industry must even now be planning the new products that will make jobs when this thing is finally over; if you are letting your imagination soar: Won't you ask us to help you engineer it down to earth with all the up-to-date facts about Alcoa Aluminum, plus some of the very practical dreams we have been dreaming?

AND THE PROPOSAL: Do some personal Imagineering, right now, for the sake of your own personal tomorrow.

We have been talking Imagineering for some months largely in terms of the future. And in terms of industry. But here is the personal slant:

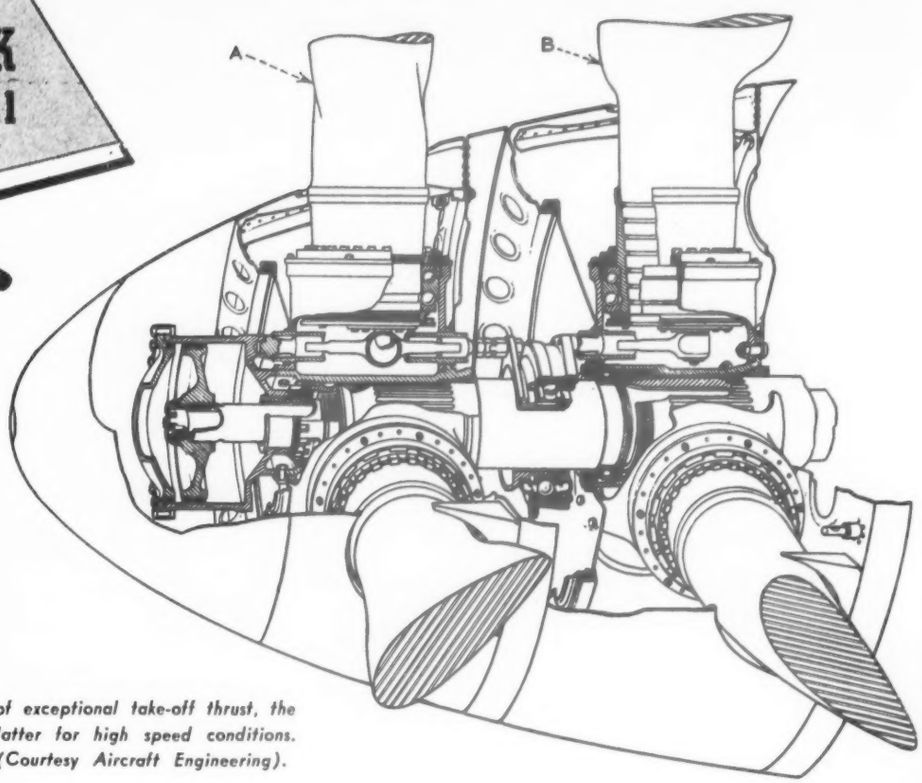
Thirty billion dollars is loose in the country. It is the gap between what is available for spending and what is available for personal purchases. Each of us has a sliver of that chunk of excess purchasing power.

If we put it into War Bonds, we are told that it will both finance the war, and avoid inflation. We sometimes forget that it will also finance ourselves, as users of goods, to buy the new products we are all readying, as makers of goods. Buying tomorrow, today, is patriotism and sense—business sense.

Aluminum Company of America, 2182 Gulf Bldg., Pittsburgh, Pa.

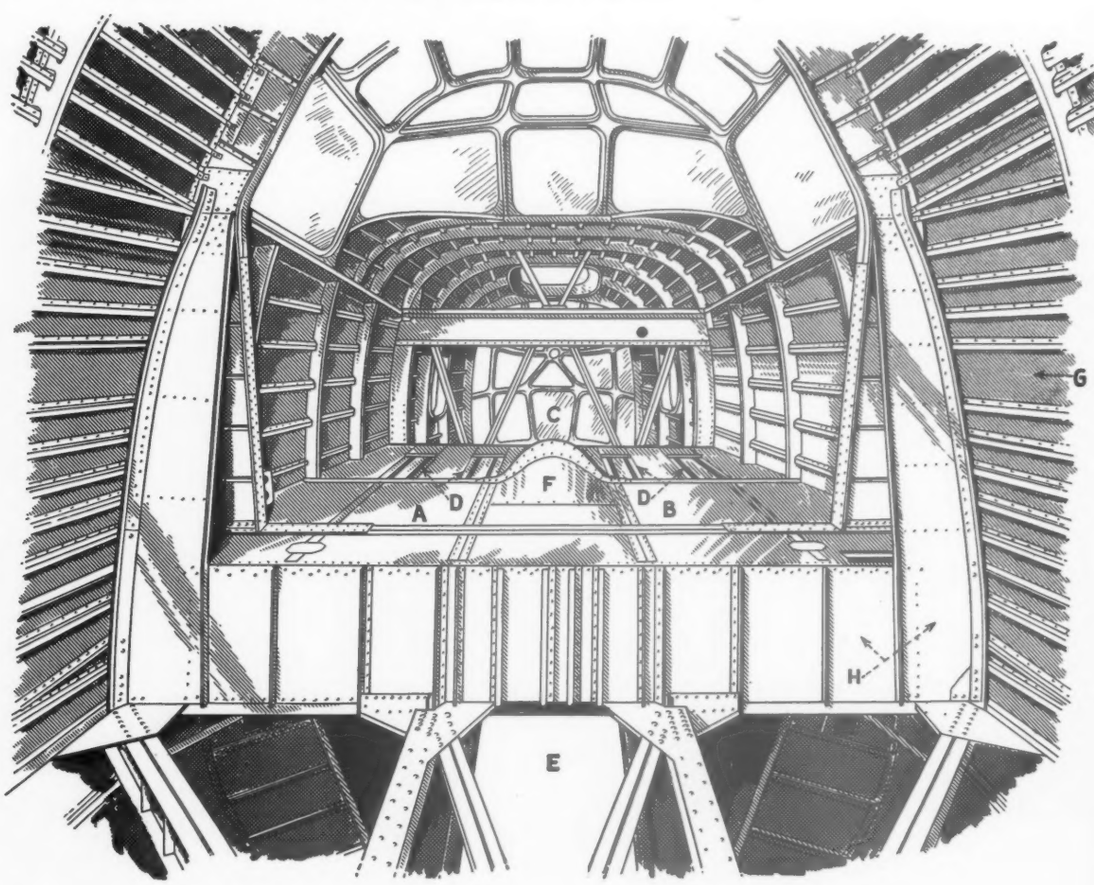
ALCOA ALUMINUM

SKETCH BOOK
of Design Detail



The Rotol constant speed contra-rotating propeller, right, consists of a pair of oppositely rotating 3-blade propellers driven by a single engine and with the pitch changing mechanisms interconnected to operate as single unit. The two half-propellers are arranged so that the front half "A" acts a left hand tractor and the rear half "B" as a right hand tractor, the distance between the two centers being 15 in. The hubs will be capable of accommodating wood or metal blades; the former of exceptional take-off thrust, the latter for high speed conditions. (Courtesy Aircraft Engineering).

The nose section looking forward in the control cabin of the Consolidated B-24 is shown at right. In this view the pilot would sit at the left at approximately "A", while the co-pilot would be at "B". The bombardier's station is located in the nose at "C". The slots in the flooring where the pilot's and copilot's control pedals will be located are at "D". The nose wheel retracts through the opening in the bottom of the ship at "E", and when retracted the tire slides into the well, the top of which is at "F". The outer skin "G" of the B-24D is .040 in. 24ST aluminum alloy, while the beams and bulkhead "H" are .025 in. 24ST.



CONSOLIDATED AIRCRAFT

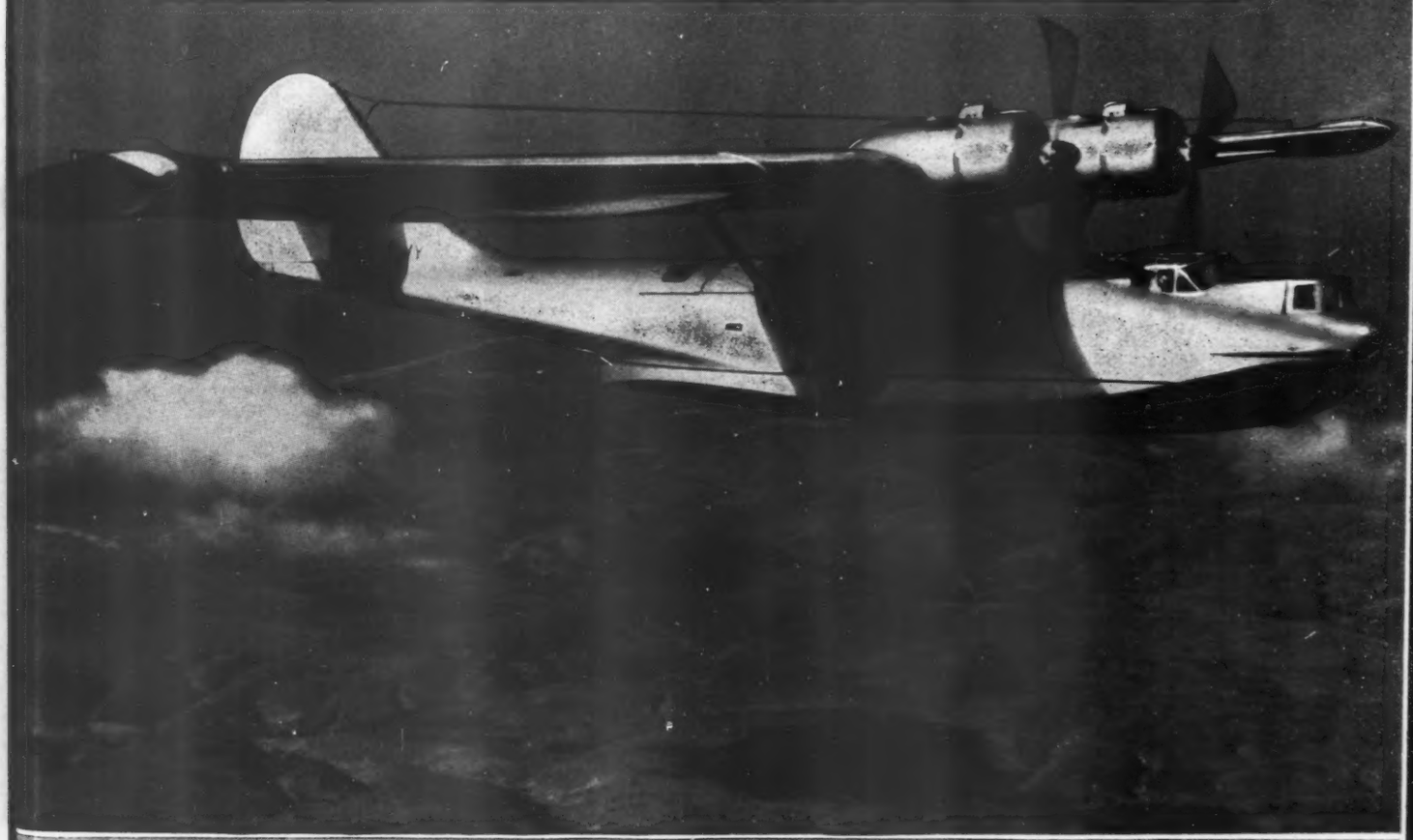
Uses VICKERS HYDROMOTIVE CONTROLS

Vickers Hydromotive Equipment is used on many of the most modern airplanes. The Consolidated Aircraft PBY-5 ("Catalina") amphibian illustrated here is representative.

Vickers Hydromotive Controls are high pressure oil hydraulic controls that are so widely used because they do the job dependably, smoothly and accurately . . . no matter how severe the service.

VICKERS *Incorporated,* 1462 OAKMAN BLVD. • DETROIT, MICHIGAN

Official Photograph, U. S. Navy



ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

HORSEPOWER for AIR POWER

WHEREVER WAR PLANES OR WAR PLANS CALL FOR SMALL MOTORS, YOU CAN COUNT ON WESTINGHOUSE TO DELIVER ON SCHEDULE . . . AND IF YOU HAVE A SPECIAL PROBLEM THAT MUST BE ANSWERED BY A SPECIAL MOTOR—WHETHER IT'S FOR A BOMB HOIST OR A FUEL PUMP WESTINGHOUSE CAN GIVE YOU PROMPT DESIGNING SERVICE WITH PERFORMANCE CHARACTERISTICS THAT CAN BE PREDICTED ACCURATELY. THE VAST EXPERIENCE GAINED FROM BUILDING THOUSANDS OF ROTATING ELECTRICAL UNITS FOR AVIATION AND THE MANUFACTURING FACILITIES NEEDED TO BUILD THEM ARE PLEDGED TO MEET TREMENDOUSLY INCREASED DEMANDS QUICKLY . . . WITH THE FINEST PRODUCTS THE WESTINGHOUSE SMALL MOTOR DIVISION HAS EVER BUILT.

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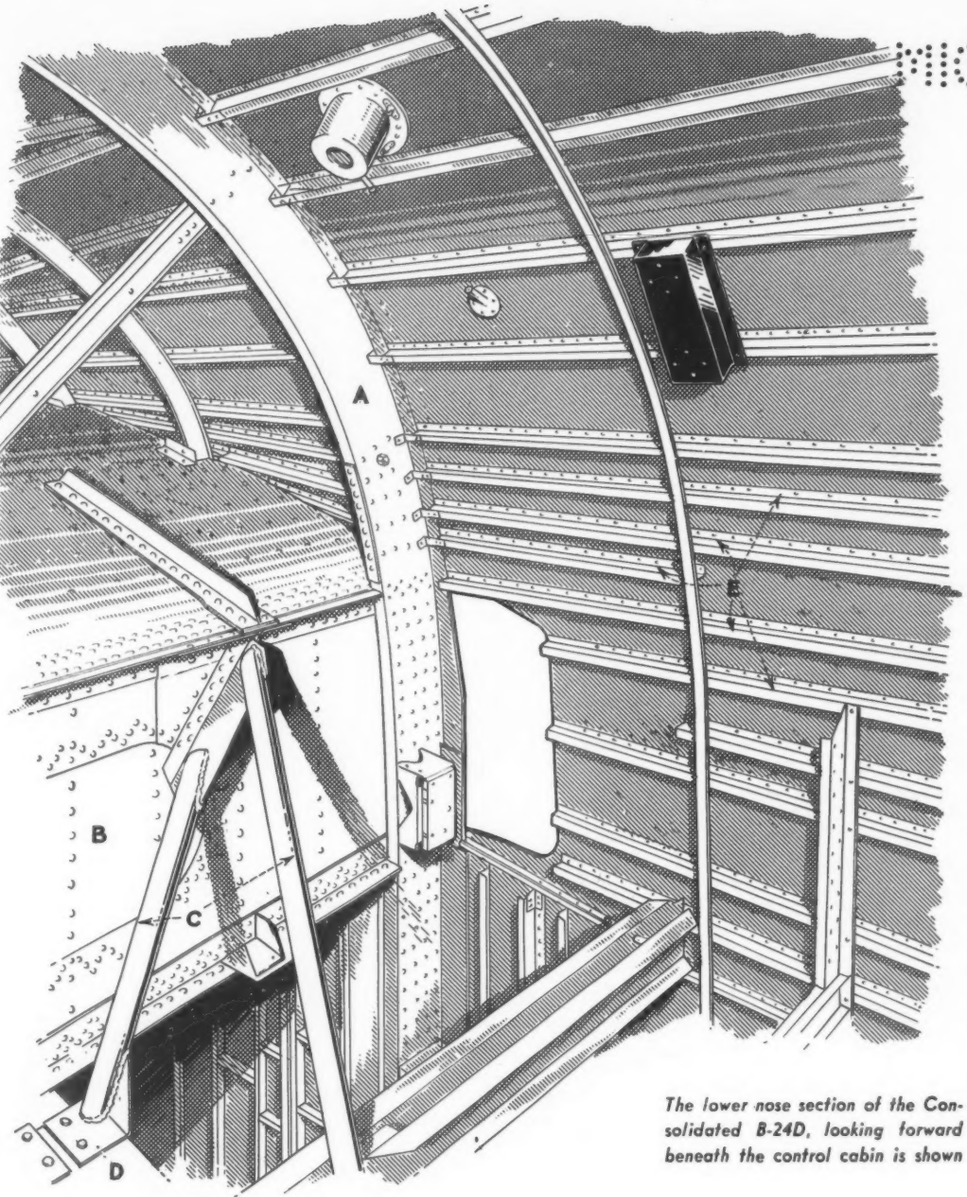
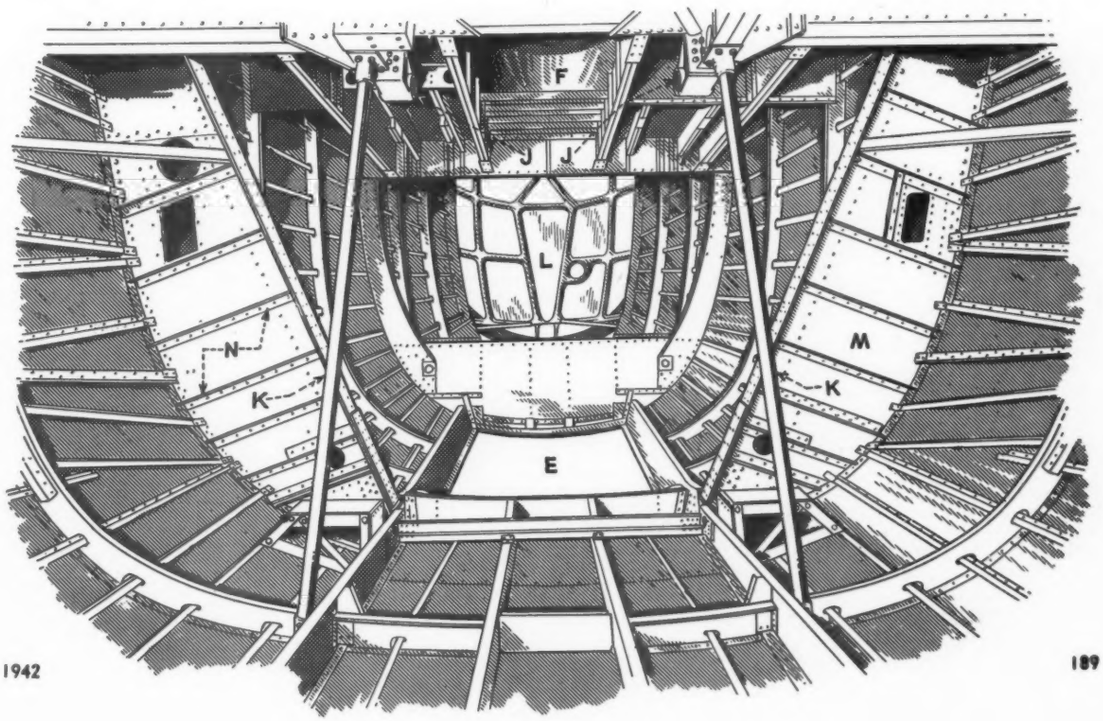
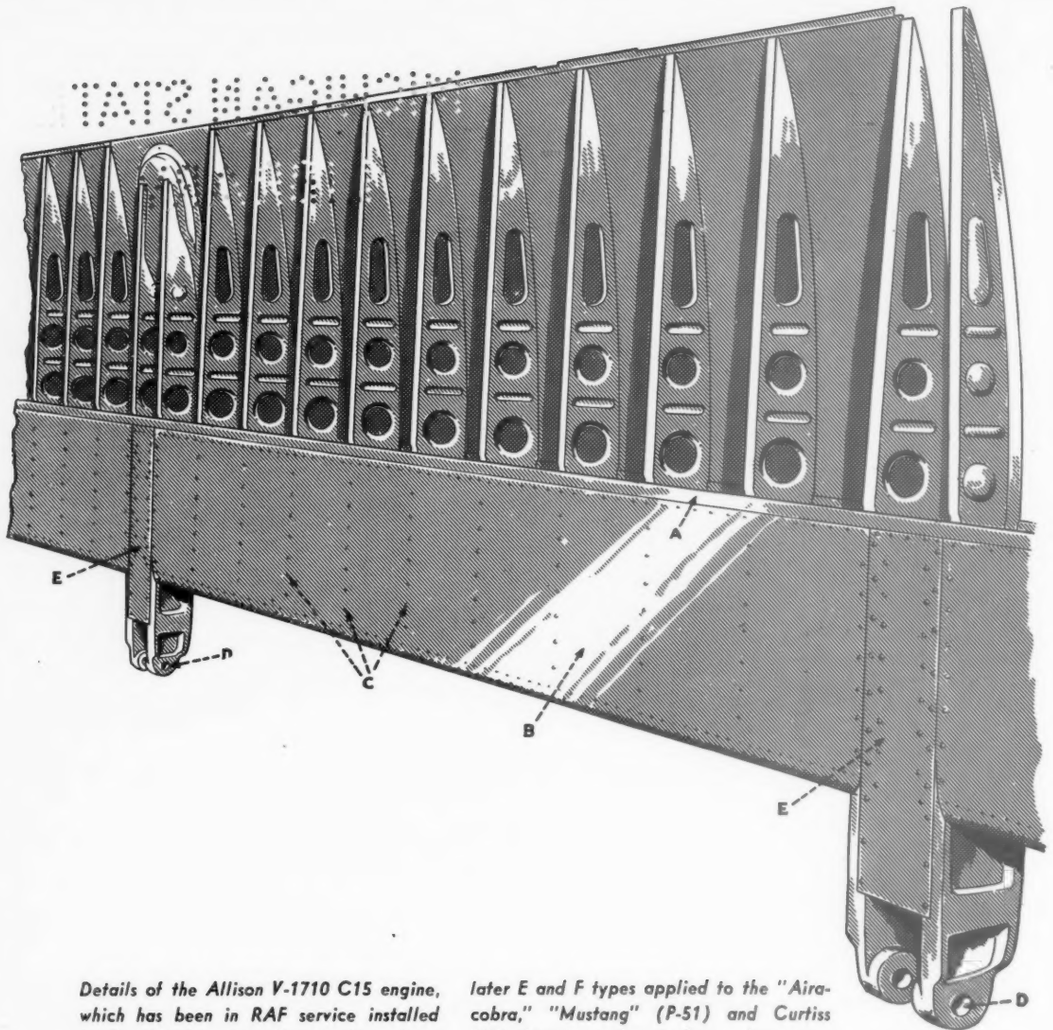


The wing of the Consolidated B-24 is attached to the fuselage just above the bomb bay. As shown at left, a reinforced former ring "A" is riveted directly to the rear spar "B", while the front spar is similarly attached. Additional support is given by the diagonal struts "C" which are attached to the main beam "D". A similar pair of struts is on the other side. The concentrated load brought into the fuselage by the wing requires additional stiffeners to be attached to the fuselage skin shown at "E".

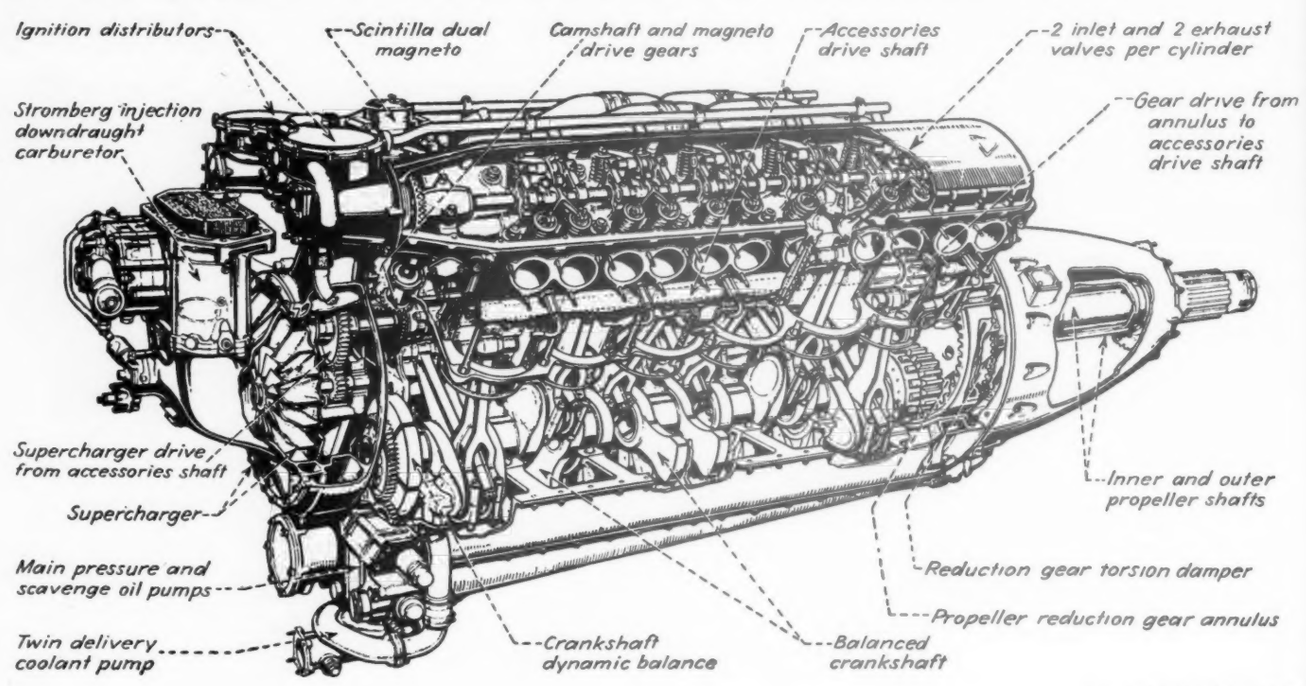
The lower nose section of the Consolidated B-24D, looking forward beneath the control cabin is shown below. Here can be seen more closely the nose wheel door "E" and the well "F" into which the wheel fits when retracted. The rear hinge points for the nose wheel strut are at "J". Additional support is given by the struts "K". The bombardier's window is at "L". The bulkhead "M" is of .032 24ST aluminum alloy sheet with reinforcing angles "N".





The wing flap structure of the Consolidated B-24 is at left. The flap is built of a main spar "A" at approximately the 40 percent chord point. Forward of this is a D-spar leading edge "B" which is formed around former ribs located where the rows of rivets "C" are exposed. The hinge points "D" of the flaps are supported out from the flap by forged aluminum alloy fittings. Loads at these points are transferred to the main flap structure through the capping plate "E".

Details of the Allison V-1710 C15 engine, which has been in RAF service installed in the Curtiss "Tomahawk," have been revealed in a cutaway drawing, below, published by our British contemporary, Flight. Installed in the P-40's and early examples of the P-38, the C15 model differs mainly in appearance from later E and F types applied to the "Airacobra," "Mustang" (P-51) and Curtiss "Kittyhawk" in that it has a long nose integral with the crankcase, enclosing the 2:1 reduction gear. Later F models are said to be installed in the "Lightning" and provided with exhaust driven turbo superchargers. Cylinders are cast in two blocks each with six cylinders set at 60 deg. Head is a separate 1-piece alloy casting. Hardened steel carburized cylinder barrels are shrunk into the head.


Ignition distributors
Scintilla dual magneto
Camshaft and magneto drive gears
Accessories drive shaft
2 inlet and 2 exhaust valves per cylinder
Stromberg injection downdraught carburetor
Gear drive from annulus to accessories drive shaft
Supercharger drive from accessories shaft
Supercharger
Main pressure and scavenge oil pumps
Twin delivery coolant pump
Crankshaft dynamic balance
Balanced crankshaft
Inner and outer propeller shafts
Reduction gear torsion damper
Propeller reduction gear annulus

The B.F. Goodrich Airliner of the month

AMERICAN AIRLINES' FLAGSHIP!

ONCE Middlesex villages and farms heard the clatter of Paul Revere's horse. Today, they hear the drone of giant motors and see the shadow of great wings! It's an American Airlines Flagship on a mission for Democracy. For now, time is of the essence, and American Airlines is playing a vital role in linking the states.

And B. F. Goodrich Silvertown Tires are helping American's pilots make safe, smooth take-offs and landings. Like all the country's leading airlines, American also flies with B. F. Goodrich De-Icers.

B. F. Goodrich salutes American Airlines and nominates its Flagship as the "Airliner of the Month!"

American flies with

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FIRST IN RUBBER

B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

The thread of this story is Rayon

Yes, rich, luxurious rayon! The fibre from which milady's gay summer dress is woven. It's this same fibre which B. F. Goodrich research found to be of great value for Silvertown Airplane Tires.

You see, B. F. Goodrich engineers got the idea that rayon might make a stronger tire cord for its weight than cotton. So they set out to prove it.

That's the secret of B. F. Goodrich Research. It looks for the unusual. It's never bound to the past or tradition.

Today, Silvertown Tires made with rayon cord are spinning on runways from coast to coast. Airlines report rayon-cord Silvertowns are stronger, longer-lasting. And they weigh less, too—a vital factor where airline payloads are concerned!

This is just one example of B. F. Goodrich Research. But it's typical of the ceaseless prying into the unknown which developed the famous B. F. Goodrich De-Icer. It's typical of the kind of research that developed the B. F. Goodrich Feed Shoe for protecting propeller blades from ice. And when we say developed, we don't mean that we're sitting back satisfied . . . that we're considering no further improvements. All B. F. Goodrich products are constantly undergoing change. We're working on them today. We will be tomorrow! That's why you can count on the next great improvement in rubber products for the aviation industry coming from the B. F. Goodrich Laboratories. For a general catalog describing B. F. Goodrich Aviation products, write our General Offices, Akron, Ohio.

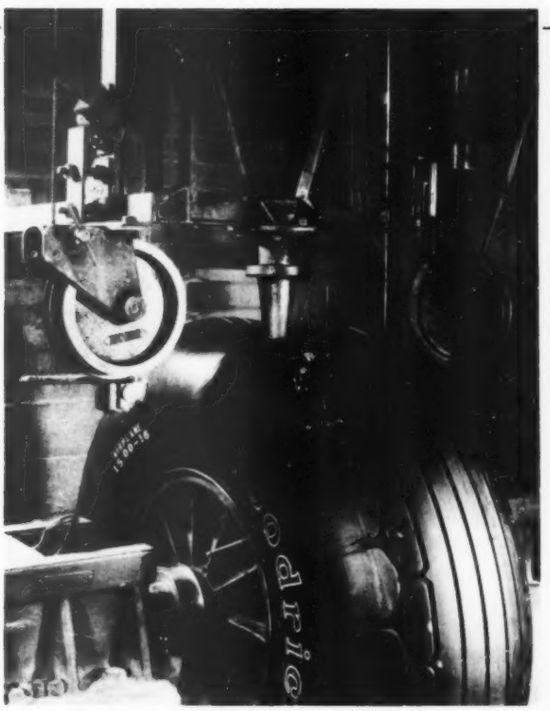
MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

LET'S GO! KEEP 'EM FLYING

TORTURE CHAMBER

MAKES B.F.GOODRICH PRODUCTS "TELL ALL"!

VING BLIZZARDS MADE TO ORDER! That's how the B. F. Goodrich Laboratories duce severe flight hazards to test B. F. Goodrich De-Icers. Zero winds rush ough this huge wind tunnel. But the pulsating action of the De-Icers attached to leading edge of the test wing breaks the ice right off!



NDEMNED TO THE GUILLOTINE! That's the fate of this B. F. Goodrich Airplane ertown—the famous low-pressure tire used by leading commercial airlines, vate and service plane manufacturers. With lightning speed, the plunger drops wn a 96-ft. shaft . . . delivers a blow that would mean death to ordinary tires. B. F. Goodrich Tires can take it!

TIRES TAKE A BEATING! The actual impact on the tail wheel of a gigantic transcontinental airliner when it comes to earth is duplicated here. That's how the laboratory proves that B. F. Goodrich Silvertowns can withstand terrific impacts.

BRAKES GET PUNISHED MERCILESSLY! Sudden stops and starts show what vital brake control B. F. Goodrich E. T. Brakes give a plane . . . whether it weighs a half ton or is a 33-ton giant. When the braking fluid enters the Expander Tube, it forces sectional brake blocks against the brake drum, bringing the plane to a quiet, smooth stop.

TCHED BEYOND ENDURANCE, Expander Tube in a B. F. drich Brake has to prove bility to take the tremen- s changes of climate found e modern theatre of war. peratures from 70° below 00° above freezing are duced in this coil. Then an nder Tube is inflated and ted thousands of times to over when it will fail.

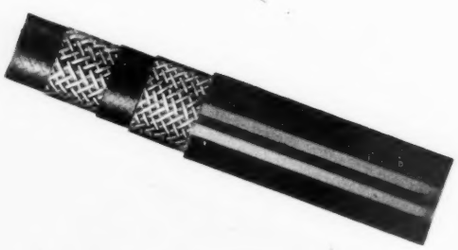
In war or peace

B.F.Goodrich

FIRST IN RUBBER

B. F. Goodrich Expander Tube Brakes

Application of a braking fluid under pressure causes the B. F. Goodrich Expander Tube to expand uniformly under a full circle of brake lining blocks. When these blocks are forced against the revolving brake drum, the plane comes to a sure, smooth stop and completes the "happy landing" both safely and comfortably.



B. F. GOODRICH FUEL AND OIL HOSE is made with a synthetic tube and braided inserts. The synthetic rubber is gasoline resistant, and prevents peeling and swelling.

B. F. GOODRICH DE-ICERS are being installed on this Flagship. The action of the De-Icers on the leading edge of wing and tail surfaces breaks up ice as it forms and allows it to be carried away in the slipstream. All the leading airlines in this country equip their planes with B. F. Goodrich De-Icers.

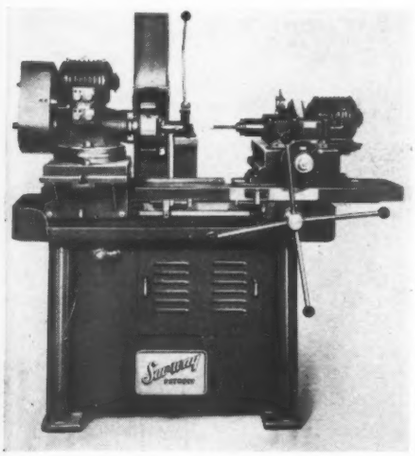
B. F. GOODRICH GROMMETS are designed to carry fuel lines and control cables through the fire wall and bulkheads; to allow entrance of the control cables through the fuselage; and for many other places where it is desired to absorb the vibration of cables and wires.

B. F. GOODRICH ★ GENERAL OFFICES ★ AKRON, OHIO

MODERN MACHINE TOOLS

New Internal Grinder

An internal precision grinder that will grind holes up to 9 in. deep and from ¼ in. to 18 in. in dia., straight or tapered sides, has just been announced by **Sav-Way Tool & Machining Co.**, Detroit, Mich. Construction of headstock is such that loosening of two nuts permits an adjustment to a distance of



3½ in. at right angles to the wheel transverse. This allows grinding of angles not heretofore reached by rotation of headstock or traverse of the wheel. Variable V-belt pulleys provide four variations of work head speed. Grinding wheel head may be adjusted to .0001. Diamond holder is of the swing type with micrometer adjustment, enabling operator to set diamond accurately for sizing holes. Machine is equipped with automatic wheel guard. Motors, bearings, coolant pump, electric controls, and grinding spindle are leading standard makes. Base is welded steel construction. Ways, table and cross slide are cast iron, hand scraped to .0002. Construction throughout is rigid, which, coupled with machining accuracy of component parts, provides perfect bearing surfaces, smooth slide fit, ease of operation, precision of grinding, maximum efficiency and long life. Machine weighs 3,130 lb. and measures 40x22 in. at the base, and is suitable for both tool room and production grinding.—AVIATION, *July, 1942.*

Tool Grinder Wheel Guard

A new scientifically designed wheel guard on Hammond's new Models 10 and 14 in. Carbide Tool Grinders has just been announced by **Hammond Machinery Builders, Inc.**, 1638 Douglas Ave., Kalamazoo, Mich.

The new guards, known as No-Spray —No-Splash, and coolant flow control keep the operator and floor dry during wet grinding operation, it is said. The guards are concealed and are close to the wheels—there being no awkward or "in the way" hoods or shields. Thus the maximum amount of light and fullest operating freedom is provided the operator. Each No-Spray—No-Splash Guard is easily rotated from one side of the wheel to the other by a handle, quickly accessible. As an integral unit, the hood (which encloses the No-Spray —No-Splash Guards) and the table mechanism, protected from ingress of dust and grit, is mounted on enclosed shaftways and is moved in or out from the wheel by a convenient crank. This provides quick means of adjustment for wheel wear and wheel changes, it is claimed. Hood is easily removed by two conveniently located socket-head cap screws on either side of hood section. Water connections inside hood are flexible hose which permits hood section to be laid on top of machine when changes are made. Wheels are then easily replaced by merely cranking forward the table unit to forwardmost position.—AVIATION, *July, 1942.*

"Temp-A-Trol" Welder

A welder in which the temperature at the weld itself automatically controls weld and heat treat current and operating cycle, and which is completely self-compensating for all such variations as normal difference in metal thickness, induction and short-circuiting losses, presence of scale, etc., has been announced by **Progressive Welder Co.**, of 3050 E. Outer Drive, Detroit, Mich. Designed

CRESCENT
is an important source of supply for AVIATION CABLE

Crescent manufactures a complete line of electric wire and cable for every aircraft need—starter cable, high-tension cable, primary cable—original or replacement. Crescent also manufactures welding cable.

And every Crescent Aviation Cable is a quality cable—made of prime materials, processed under the Dostam Method of manufacture for high efficiency, long life, dependability and uniformity.

We will promptly answer your inquiries concerning wire or cable for any type of service.

THE CRESCENT COMPANY
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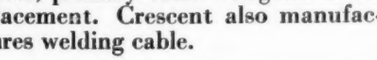
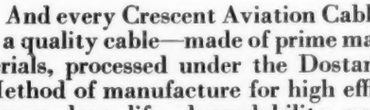
Largest independent maker of replacement wiring for the automotive industry

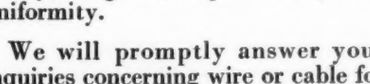
Lighting Cable



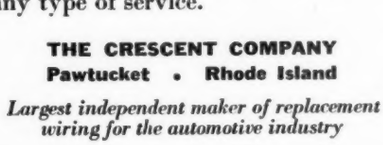
Two-Conductor Cable



Ignition Cable



Starter Cable



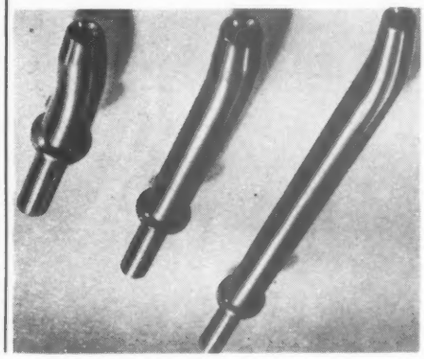
Available in both shielded and unshielded constructions.

P.S.
OF COURSE, CRESCENT WIRE AND CABLE FOR THE AIRCRAFT INDUSTRY MEETS ALL ARMY AND NAVY SPECIFICATIONS . . .
Wiry Joe

for resistance welding of heavy sections and of special alloy steels—such as homogeneous and face-hardened armor-plate, the new Progressive "Tem-A-Trol" forge welder both spot-welds and heat-treats the weld. Close control of weld nugget size, ductility and grain refinement are thus obtained. It is said that the welder also avoids annealing of hardened surfaces in plate. With completely automatic control of weld, heat treat and annealing cycles, the new Temp-A-Trol reduces the human element in selecting weld and heat treat cycles to a mere setting of the dials to the actual temperatures desired. Another advantage of controlling welding current and cycle through weld temperature rather than by the conventional manual setting of current and time regulating controls is that it provides automatic compensation for current loss due to varying amounts of the work introduced in the throat of the welder. As this increases, the current loss due to induction increases, causing a variation in the actual amount of welding current—almost impossible to compensate for accurately by means of manual controls. Again, the Temp-A-Trol control also compensates for current loss through adjacent completed welds. Obviously, when a spot weld is made close to another completed weld, part of the "welding" current will short circuit through the already completed weld, causing a variation in the actual amount of current used for welding and in the size of the weld nugget. With Temp-A-Trol welding, this loss is meaningless since the amount of current is automatically increased to compensate for the loss. Detailed information on the new process will be furnished at present only to organizations engaged in or contracted to engage in war production work.—AVIATION, *June, 1942.*

Aero Tool Rivet Sets

Designed with angular offsets of 7½ deg., 10 deg., and 15 deg., a new line of offset rivet sets has just been announced by the **Aero Tool Co.**, Burbank, Calif. Incorporated in the manufacturing is a process known as Microglass polishing, which is said to develop a glass-smooth face that will not harm aircraft skins or other surfaces the tools contact. Also, incorporated in the manufacture is the Aero Tool Co. cup-forging process which assures an even metal flow and structure for long wear and extreme precision. — AVIATION, *July, 1942.*



Tap Reconditioner

Designed to alleviate current difficulties in securing the vast numbers of precision ground taps required for war production needs, a Tap Reconditioner is announced by **Detroit Tap and Tool Co.**, 8432 Butler St., Detroit, Mich. Combining in one unit facilities for

chamfering, for spiral pointing and for point polishing, the Detroit Tap Reconditioner serves to eliminate delays in tap replacements by simplifying reconditioning of taps. In addition, the Detroit Tap Reconditioner is said to reduce tapping costs by increasing the output per tap during its useful life. The machine thus also means the avoidance of delays in securing tap replacements by endowing "old" taps with new life, time after time. The tap chamfering unit, located at left of machine is of the precision collet type, assuring maximum locating accuracy with quick changes. It will accommodate collets from the smallest machine screw size up to the 1¼ in. standard tap shank size. Taps of from two to seven flutes may be handled through the provision of an indexing drum, indexing being accomplished by pulling the dual purpose control lever sideways to release the spring plunger. Proper index for different numbers of flutes is selected by moving

New Products

the drum assembly in or out until the number corresponding to the number of flutes appears in an inspection aperture. Graduations are provided for adjustment to desired chamfering angle. Safety stop pins limit the movement of the chamfering unit for taps of different numbers of flutes. The oversize grinder motor is of the double-end shaft type, is of dust-proof construction and mounted on ball bearings.—AVIATION, *July, 1942.*

Monarch "Streamliner"

Possessing exceptional beauty of design, with streamlined arm guard, and cabinet base, the new Monarch Radial Saw "Streamliner" made by the **American Saw Mill Machinery Co.**, Hackettstown, N. J., was designed to meet the national trend for the utmost speed and efficiency in production. This machine incorporates the "Uni-Point" principle, permitting operator to make an instant setting for any crosscut angle, with the saw blade always cutting into the work at the same point in the table. This feature enables the operator, with snap-speed accuracy, to set the machine for any cut without raising or lowering the saw or making any other complicated adjustments.

In addition, the machine has a number of new mechanical features which further simplify the operation. The capacity of cross cutting has been considerably increased on all standard models, to take care of the widest pan-

PROMPT DELIVERY*

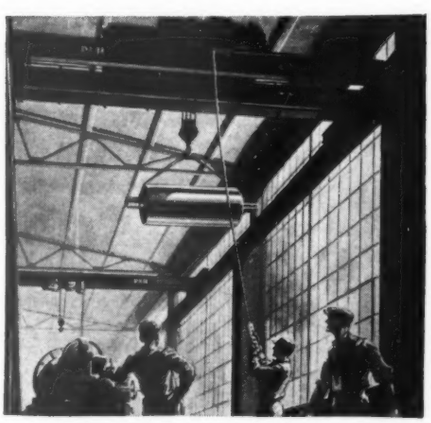
"Saved our necks!"

● "Production at full speed by the 10th . . . or else! That was the job that faced us. It meant new materials handling equipment — and a delivery date we could absolutely depend upon. Again, we turned to P&H because we know they won't make a promise they can't keep. This time they beat the promise . . . and enabled us to keep ours!"

★ **To meet the urgent need of the war program, P&H guarantees delivery date within ± 3%.**

P&H TRAV-LIFT CRANES FOR INTERMITTENT SERVICE

Around production lines, assembly floors, warehouses, loading zones, and in countless other locations, P&H Trav-Lift Cranes provide swift, low-cost materials handling to speed the war effort. Designed for intermittent service, P&H Trav-Lifts are offered in a variety of sizes and types with capacities up to 15 tons. Write for bulletin H-13.

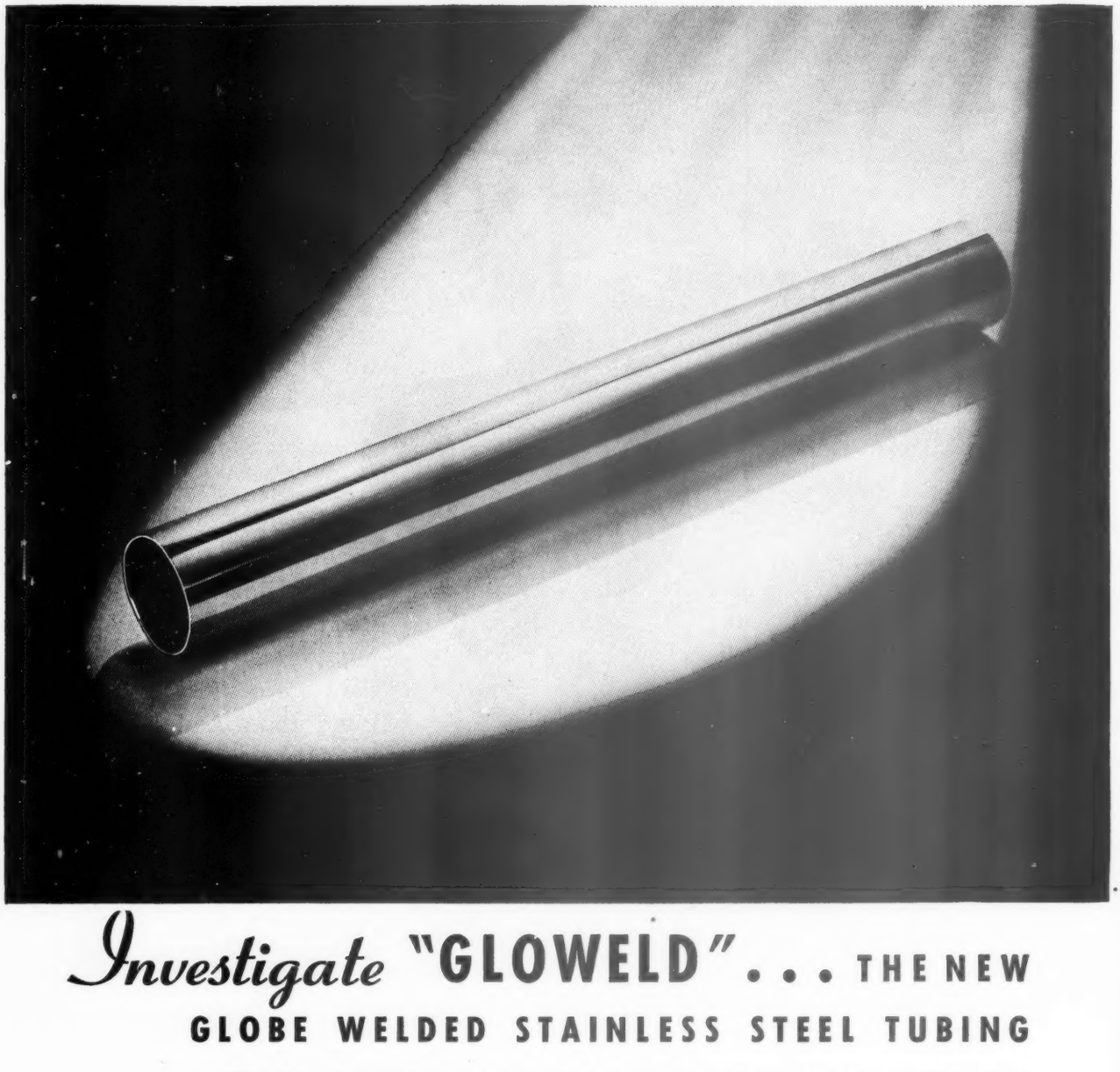


Awarded the Navy "E" for excellence in war production, P&H displays it also as a pledge of future effort.

General Offices: 4593 W. National Avenue . . . Milwaukee, Wisconsin

HARNISCHFEGER CORPORATION

HOISTS • WELDING ELECTRODES • MOTORS P&H EXCAVATORS • ELECTRIC CRANES • ARC WELDERS



Investigate "GLOWELD" . . . THE NEW GLOBE WELDED STAINLESS STEEL TUBING

. . . Gloweld is the result of a long period of research and experiment by the Globe Steel Tubes Co., pioneer manufacturer of stainless steel tubing.

It is produced by a closely controlled electric welding process that gives it unusually smooth finish — "flash" is hardly detectable. Gloweld's light weight, high resistance to corrosion, heat and pressure, comparatively lower cost, and other advantages will find many applications for tubing in chemical and process industries, food industries, pulp and paper, oil and other industries where these factors are needed. It is already in use in aircraft construction — as hydraulic lines, for frame and engine parts. Available in a wide range of diameters and wall sizes, in practically all stainless steel analyses. Write for full information.

GLOBE STEEL TUBES CO • MILWAUKEE, WISCONSIN

GLOBE TUBES

4000

- Stainless Tubes
- Boiler Tubes
- Condenser and Heat Exchanger Tubes
- Mechanical Tubing

GLOBE STEEL TUBES

el-board. Thirty-two roller bearings in the ram house assure "light-pressure" precision travel of the saw, easy operation, and reduction of wear to a minimum. A spring bumper on the ram housing cushions the back stroke and assists in starting the forward motion of the saw. The adjustable crank-feed bar, which mechanically controls the saw travel for heavy dado work and other difficult cuts, is another unique feature. The feed bar can be locked in any location, so as to place the operating crank in the most convenient position, or it can be pushed back out of the way, when not in use.

The safety features of the new machine are of the utmost importance. All adjustment and locking levers are in front of the machine and below the table, in the "safety zone." When making adjustments, it is never necessary for the operator to reach over the machine which might result in catching his clothing on the saw, etc. It is not necessary to raise or lower the saw when adjusting for any horizontal, vertical, or compound crosscut angle. Furthermore, the machine is provided with an adjustable guard, having an effective anti-kickback device. The guard can be brought down close to the work, for ripping, cross-cutting, or performing other operations such as dadoing. Another important safety feature is the telescoping ram which returns the saw behind the fence, leaving the table free and clear of all obstructions, and eliminating the danger of the operator striking his head or shoulder against the ram.—AVIATION, *July, 1942.*

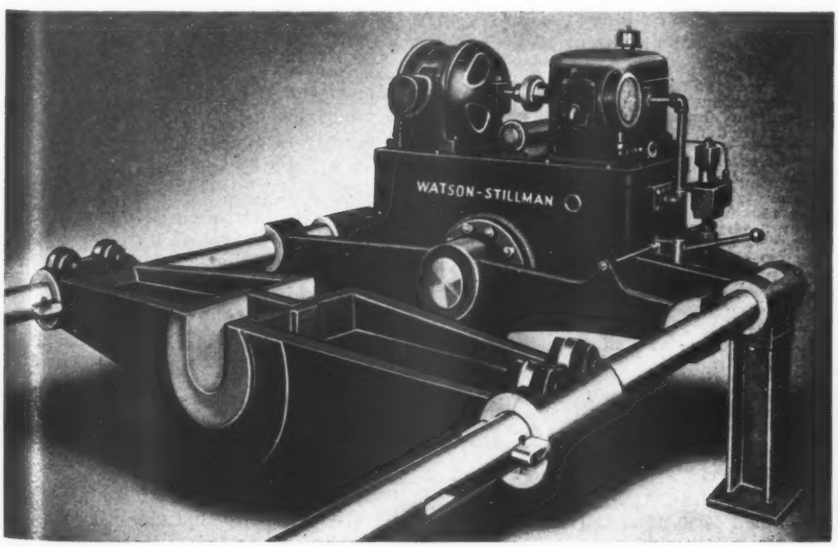
100 Ton Forcing Press

A new 100-ton forcing press has just been completed by the **Watson-Stillman Co.**, Roselle, N. J. The press represents an improvement over former

types in that control of all motions is by a single hand lever. The unit is entirely self-contained, including 10 hp. motor and variable delivery radial piston pump. The press is of the horizontal, two-bar type. It may be used for forcing shafts into rotors but is also suitable for any other forcing operation. Distance between bars is 72 in. Opening is adjustable from 24 in. to 120 in. Stroke of ram is 18 in. Gap in the rear abutment is suitable for holding shafts up to 6 in. dia. Advance speed is 200 in. per min., pressing speed variable from 0 to 25 in. per min. and return speed is 140 in. per min. The entire unit, designated as Machine No. 8676, weighs 10,000 lb.—AVIATION, *July, 1942.*

Rotary Surface Grinder

Currently introduced by the **Taft-Pierce Mfg. Co.**, Woonsocket, R. I., is a machine which incorporates new and different principles in rotary surface grinder design. Its distinct individuality lies in its ability to produce surfaces which are flat within extremely close limits of tolerance, and among its features is a tilting wheel-head which makes the machine suitable for difficult shoulder work. This machine is almost effortless in operation, and long life is assured by the hardened and ground ways and the ball-bearing travel of saddle and column. The 6 in. Rotary Surface Grinder is designed to impart the highest possible degree of accuracy, flatness, and finish to the plane



CLEVELAND AIRCRAFT

Leathers

AEROKROME

All grades — All types

Here's Cleveland Tanning's most recent contribution to service and savings in the greatly expanding aircraft industry — AEROKROME . . . a highly efficient and attractive leather covering suitable for every aircraft upholstery use. A specialized product developed exclusively for aircraft use, AEROKROME is light in weight, resists excessive wear, and provides a tough, easy-to-clean, covering for seats and sidewalls. AEROKROME is available in a full line of chrome tanned leathers — also "Cleveland" specializes in a full line of bark or vegetable tanned leathers. Both may be had in natural tone or finished to meet any color matching requirements.

Remember—more than 50 years of "know how" in commercial leathers lies behind Cleveland Tanning's Aircraft Leathers . . . experience and knowledge of how, what, why and where leather can do the job. This half-century of engineering design and quality production is yours to use . . .

. . . LET CLEVELAND QUOTE ON YOUR LEATHER REQUIREMENTS—INQUIRIES ARE INVITED

50 Years in Leather

CLEVELAND TANNING Company

SOLE SELLING AGENTS FOR

PLUMER LEATHER COMPANY, INC.

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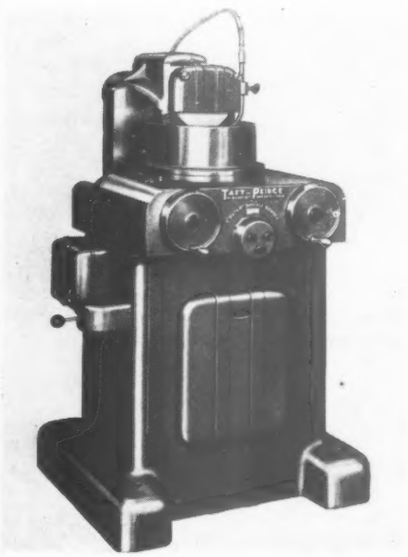
J·S·STAEDTLER·INC·NEW YORK

NATIONAL DISTRIBUTORS:
KEUFFEL & ESSER CO.
NEW YORK

surfaces of gages, tools, and parts. An exclusive feature is in the mounting of the wheel spindle, which swivels in a vertical plane about the center of the wheel. The spindle is carried in an accurately bored cast-iron block mounted between two pairs of circular dovetail slides, permitting swiveling of the entire spindle about the wheel center through an arc from horizontal to 30 deg. below center. A simple adjustment



of the spindle block makes possible operations which formerly required difficult and time-consuming set-ups of tools. Wheel clearance being readily provided, grinding to sharp corner or shoulder is greatly simplified. The ball-bearing, quill-type wheel spindle is driven directly from a 1 hp. motor at 3,600 rpm. Motor control is provided through a toggle switch mounted on the right side of the pedestal below the saddle. The spindle, being a complete and self-contained unit, is readily removable.

Specifications

Chuck:
110 v. or 220 v. d. c.
Work surface: 6 in. dia.
Height of chuck above floor: 40 in.
Height under wheel: 12 in.

Work Spindle:
120 rpm.
Motor ¼ hp.—3450 rpm.
220-440 or 550 v.
2 or 3 phase—50 or 60 cycle.

Cross Travel of Saddle:
Total travel: 4 in.

Vertical Travel of Wheelhead:
Total travel: 12 in.
.050 travel per revolution of handwheel

Wheel Spindle:
1 hp., 3600 rpm. standard spindle available in 220, 440, or 550 v. for 2 or 3 phase
50 or 60 cycle a.c. 50—cycle spindles will operate at approximately 3,000 rpm.

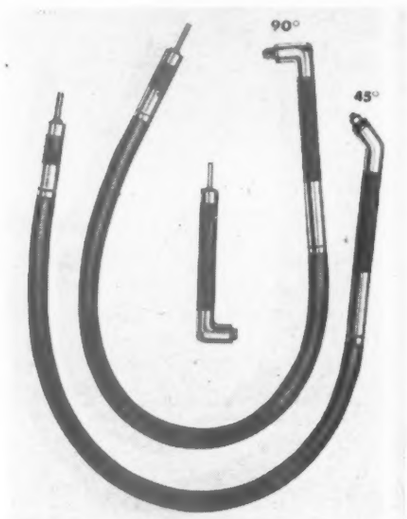
Grinding Wheel:
7 in. dia., ½ in. thick, 1¼ in. hole.

—AVIATION, *July, 1942.*

Stow Flexible Shaft Units

Wherever there are awkward drilling jobs to do, these Stow Flexible Shaft Units with 45 deg. and 90 deg. angle heads will prove most satisfactory. Made by **Stow Manufacturing Co., Inc.**, Binghamton, N. Y., these units are easily hooked up, by simply fitting the end of the shaft into an electric drill chuck. These flexible shafts provide maximum angularity with greatest strength and long life of both core and casing. Standard shaft length for these units is 30 in.

Both the 45 deg. and 90 deg. angle drill heads are built for heavy-duty service, being gear-driven, full ball-bearing type, and permanently attached to the flexible shaft. Spindle heads are threaded for adapters, ¼-28 thread, accommodating either stub

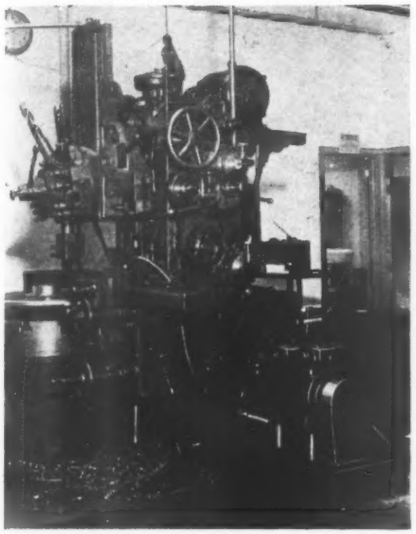


or full length drills up to No. 30 size. Clearance distance, from drill center to outer surface of angle head housing, ⅜ in.—AVIATION, *July, 1942.*

Western "Super"

Application of a Western Super transmission to a Bullard 42 in. vertical boring mill—it is equally well suited to replacement of the gear boxes on the 36 in. and 5 in. sizes of Bullard and all other makes of large boring mills, radial drills etc.—is announced by **Western Mfg. Co.**, 3428 Scooton Ave., Detroit, Mich. With eight speeds in geometric progression (1.29—a maximum reduction of 6 to 1) Western Super will handle motors from 10 to 30 hp. and can be used for motorizing large slotters, engine and turret lathes. The Western line of transmissions now consists of three models which will take care of modernizing used machine tool equipment requiring from 1-30 hp. motors—the Master (1-5 hp.); the Major (5-10 hp.) and

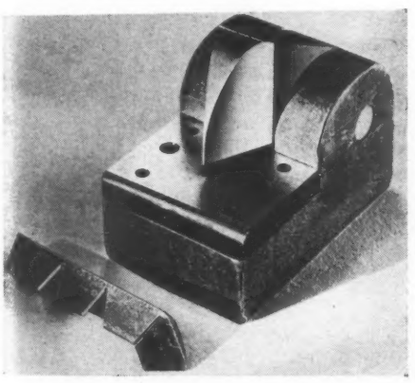
New Products



now the Super (10-30 hp.). Three models of "Multi Motor Mounting" adapt these three models of **Western** transmissions to all kinds of machine tools.—AVIATION, *July, 1942.*

Wales Notching Dies

A new line of Wales Notching Dies made by the **Strippit Corp.**, Buffalo, N. Y., are designed to notch eleven gage angle iron right up to the leg. In the case of an angle to be bent, the dies leave a portion of metal unnotched in the corner to permit easy and exact bending into position for simplified precision welding of the legs. Dies are self-contained with the punch and die in constant alignment. A line-up of these dies on a T-slotted plate will do a complete notching pattern in one stroke of the press. Flexibility of the dies makes it possible to set up patterns by positioning the holders to a template and then locking them onto a T-slotted plate. —AVIATION, *July, 1942.*

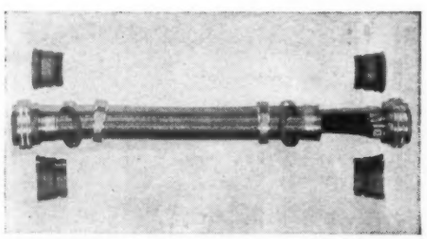


THE *Split Shell* ...pioneered on

CANNON PLUGS

The highly practical split shell for electrical connectors is an original development of Cannon Electric and is now universally used. It is only one of many improvements we have made for aircraft electrical systems to reduce weight and save time.

Cannon Plugs have many other equally important advantages. That's why they are standard equipment in aviation, radio, television, submarines, geophysical research and many other fields where quick assembly, precision and absolute dependability are required.

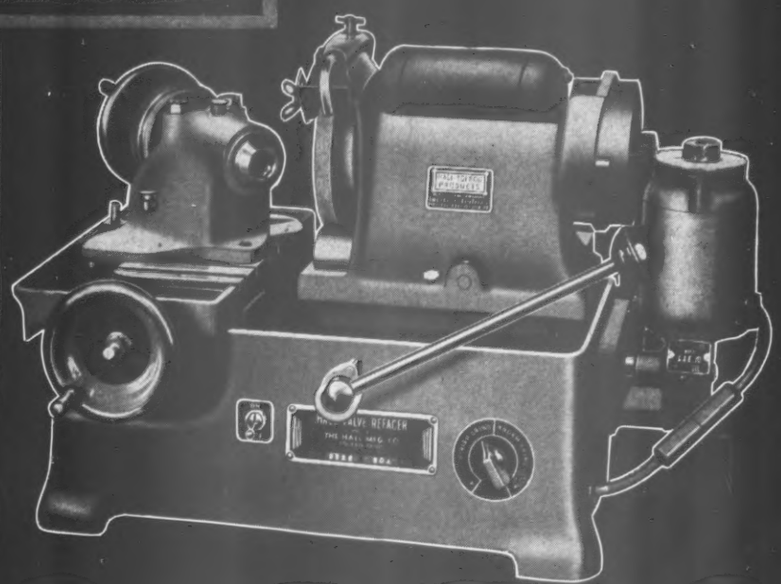


MAKES POSSIBLE USE OF SHORT CABLES—SAVES WEIGHT
When shells are removed conduit can be slid back over the cable at either end, making room to solder or rearrange connections without having slack in the cable.

CANNON ELECTRIC
DEVELOPMENT COMPANY
LOS ANGELES • CALIFORNIA

PRECISION IS AS IMPORTANT IN AERO VALVE MAINTENANCE AS IN PRODUCTION

With precision must go finest finish . . . speed is important too, and economy is desirable. HALL ECCENTRIC Valve Seat Grinders and Wet Type Valve Refacers bring all four of these factors to aero valve and valve seat maintenance. That's why HALL equipment has been so universally adopted for both maintenance and production of engines for United Nations' planes as well as tank, truck, auto and marine units. Write for information.



HALL VALVE SERVICING EQUIPMENT

HALL MODEL 80A
WET TYPE
AERO VALVE REFACER

Designed and built expressly for servicing aero valve faces to their original precision and finish. Not an auto valve refacer made over. Has dual motors with workhead motor rheostat—controlled to provide variable speeds for valve faces of various sizes and materials. Built-in wet grinding feature with large capacity sump insures finest precision and finish and control of abrasive dust and grindings. HALL patented chuck holds stems securely without marking or brinneling. Micrometer feed permits removal of exact amount of metal desired. Many other features. Write for complete details today.

The Hall Manufacturing Co., Toledo, Ohio, U.S.A.

Worthington AIRFIELD "Grass Blitzer"

THE MOST EFFICIENT, MOST ECONOMICAL UNIT YET DEVELOPED FOR AIRFIELD TURF CUTTING

Fast enough to keep out of the way of plane traffic. Short-wave radio available for directional control to eliminate collision hazards.

Experience has shown that *at least 10 cuttings* a season are required for development of the best turf conditions, which is important, because thick, dense turf:

1. Keeps down dust which is a cause of too frequent motor tear-downs and parts replacements.
2. Helps eliminate hazards of loose stone, aggregate, gravel, etc., injuring propellers during motor revups, take-offs and landings.
3. Absorbs rainfall, preventing muddy areas and the danger of serious skids.
4. Helps eliminate wheel marks which can be photographed from as high as 30,000 feet.

Speed plus economy of gasoline and man power are important when the total acreage of Military and Naval fields in this country alone is considered. Three available types of mower combinations are:

(1) The farm tractors with 7-ft. sickle bar (max. speed 6 m.p.h.).

(2) The same tractors with 7-gang golf course type cutting units cutting a swath of 16 feet, (max. speed 6 m.p.h.).

(3) The Worthington "Grass Blitzer" including special Airfield tractor and special 9-gang cutting element with a swath of 21 feet, (max. speed 20 m.p.h.).

The following table shows a quick summary of the economies effected by the "Grass Blitzer," based on 1 complete cut of 500 acres and 10 cuts per season:

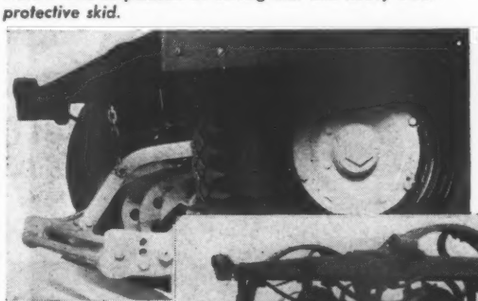
Labor hours per 500 acres cut			*Labor hours per season*		
Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
130	45	11	1300	450	110
Gallons of gasoline per 500 acres cut			*Gallons per season*		
105	68	27	1050	680	270

Simple multiplication shows gigantic savings as acreage mounts, which are also reflected in proportionately lowered operating costs.

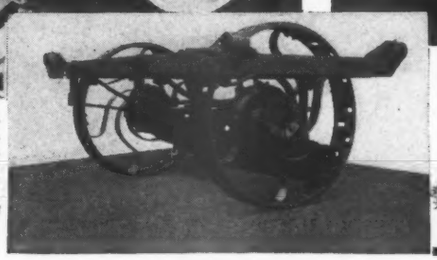
The tremendous capacity of the "Grass Blitzer" is made possible by an entirely new type of gang-mower. Castors and rollers have been eliminated — only large traction wheels touch the ground and the height of cut is established by *suspension from the frame* instead of *from the ground up*. This enables the fast Worthington tractor to haul the 9-gang at 20 miles per hour, cutting 46 acres per hour, or 368 acres per 8-hour day.

Tear out and mail this coupon, today, for handsome, illustrated catalog—"The Worthington Airfield 'Grass Blitzer' —A Study of Airfield Turf Area Grass Cutting and Maintenance Problems."

Note frame suspension of cutting unit and heavy steel protective skid.



In the interests of rubber conservation, Worthington's engineers have developed this wheel with spring steel spokes that simulates pneumatic action with no sacrifice of capacity.



"Grass Blitzer" trailer to facilitate maintenance of widely scattered Dispersion Fields.

COUPON

WORTHINGTON MOWER COMPANY
Dept. A/JY, Stroudsburg, Pa.

Please send catalog giving details and specifications of the Worthington Airfield "Grass Blitzer."

NAME_____

ADDRESS_____

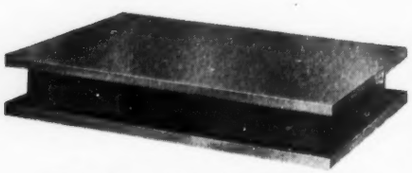
CITY_____ STATE_____

WORTHINGTON MOWER COMPANY
MAIN OFFICE: STROUDSBURG, PA.

Sales Agencies All principal cities

IT'S A CHALLENGE

DOUBLE UTILITY



Working surfaces, top and bottom. Made in three styles — one stock size, 10x14x2⅝ inches.

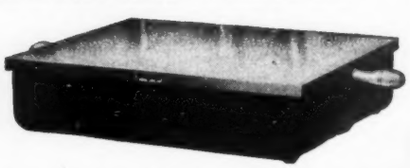
DUPLEX Semi-Steel BENCH BLOCKS

Precision Ground

● Challenge Duplex Bench Blocks are available in three combinations . . . (1) one surface smooth and the other grooved in ½-inch widths for lapping metal-to-metal joints (2) both sides smooth, so that one surface may be used for working purposes and the other held in reserve for layout and assembly (3) both surfaces grooved for lapping ½-inch mesh. These blocks can serve as a ready-built base for small fixtures and tools. Precision ground, both top and bottom. Can be furnished with either or both surfaces hand-scraped at extra cost, if desired.

★ ★ ★

CHALLENGE Semi-Steel SURFACE PLATES



A true surface for tool making, testing, etc. Built to retain accurate plane surface. Will not sag. Made of close-grained semi-steel—*hand-scraped.* Also furnished with precision ground surface. 418

LATEST CATALOG illustrates and describes complete line of Challenge Precision Equipment. Send for it today!

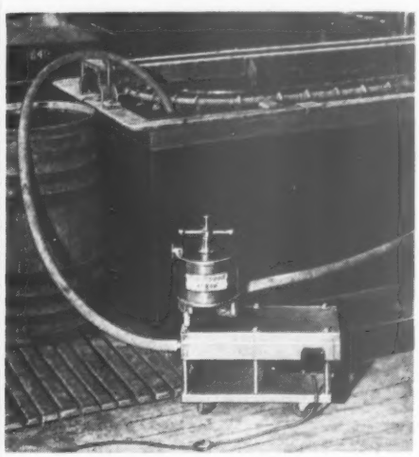
THE CHALLENGE MACH. CO.
GRAND HAVEN, MICH.

SHOP EQUIPMENT & ACCESSORIES

"Sealed Disk" Filtration

New Products

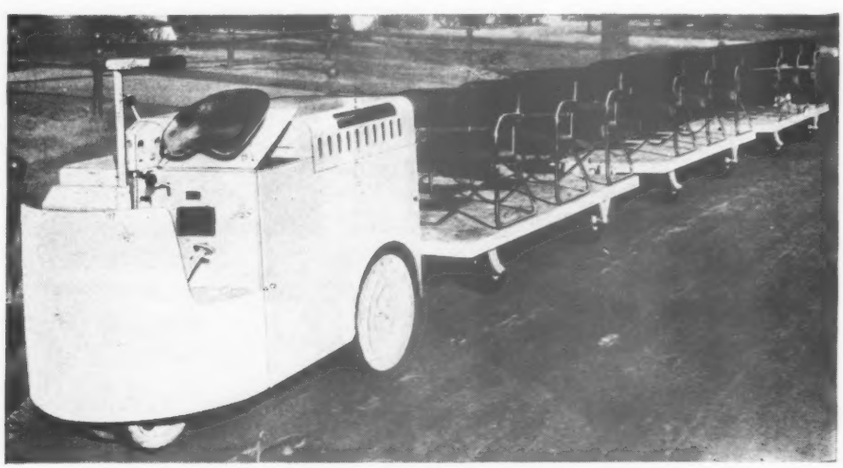
One bottleneck in the finishing of plated parts for airplanes is imperfect finishes, spotty or otherwise, which experience has proved is generally caused by dirt, dust, rust particles, sediments, colloidal and other foreign matter in plating solutions and the water used in them. The "Sealed Disk" method of filtration as used in "Hy-Speed" Filters, made by **Alsop Engineering Corp.**, 1 Hillcrest Ave., Milldale, Conn., will completely remove these impurities, even to microscopic particles, and keep liquids clean and highly clarified. The result of this filtration is a finer, faster and more uniform finish on metals, no loss of variable solutions, because filters are absolutely leakproof, rejects cut



to minimum, and production speeded up. Alsop Hy-Speed Filters are made in various sizes for all kinds of liquids, in portable form with pump and motor or for permanent installation with pipe line connections. The important uses thus far proved in the aviation field are filtering water plating and chemical solutions, metal cleaning solvents, salvaging hydraulic, turbine and fuel oils, gasoline. The very practical design of this filter makes cleaning it, and renewing the inexpensive filter disks used, a simple and quick operation. The large filter areas provided in comparatively small space assure high speed filtration. —AVIATION, *July, 1942.*

Industrial Transportation

With the building of new plants, many of which cover acres of land, the question of transportation for personnel and visitors from one section of the plant to another has become quite important. **The Mercury Mfg. Co.** of Chicago, manufacturers of industrial trucks, tractors, and trailers, have recently announced a new tractor and trailer designed for this work. The tractor is the popular Mercury A-540 electric "Tug", a compact machine easily maneuvered. The trailers are modified constructions of the popular Mercury A-310 with specially designed floor boards and comfortable seats erected on them. Wheels are rubber tired, and coupling is by means of the Mercury Safety-Self-Coupler, which simplifies coupling and uncoupling and provides smoother riding and trailing qualities to trailers. The electric feature of the tractor makes it exceedingly popular for this type of work. As there are no gas fumes, or possibility of becoming a fire hazard, the tractor and trailers may travel safely through the plant.—AVIATION, *July, 1942.*



NO MINERAL OIL

NO VEGETABLE OIL

NO WAX

MINERAL OIL. Most tracing papers are treated with some kind of oil. Mineral oil is physically unstable, tends to "drift", never dries completely. Papers treated with mineral oil pick up dust, lose transparency with age.

VEGETABLE OIL, chemically unstable, oxidizes easily. Papers treated with vegetable oil become rancid and brittle, turn yellow and opaque with age.

ALBANITE is a crystal-clear synthetic solid, free from oil and wax, physically and chemically inert. Because of this new stabilized transparentizing agent Albanene is unaffected by harsh climates —will not oxidize with age, become brittle or lose transparency.

A new synthetic solid gives you this *permanent* tracing paper

A remarkable new transparentizing agent developed in the K&E laboratories—produces this truly permanent tracing paper! ALBANENE is made of 100% long fiber pure white rags—treated with *Albanite*—a new crystal clear synthetic solid, physically and chemically inert. ALBANENE will not oxidize, become brittle or lose transparency with age.

Equally important, ALBANENE has an excellent drawing surface that takes ink or pencil beautifully and erases with ease... a high degree of transparency that makes tracing simple and produces strong sharp blueprints... extra strength to stand up under constant corrections, filing and rough handling. ALBANENE has *all* the working qualities you've always wanted—and *it will retain all these characteristics indefinitely.*

Make ALBANENE "prove it" on your own drawing board. Ask your K&E dealer or write us for an illustrated brochure and generous working sample.

EST. 1867

KEUFFEL & ESSER CO.

NEW YORK—HOBOKEN, N. J.

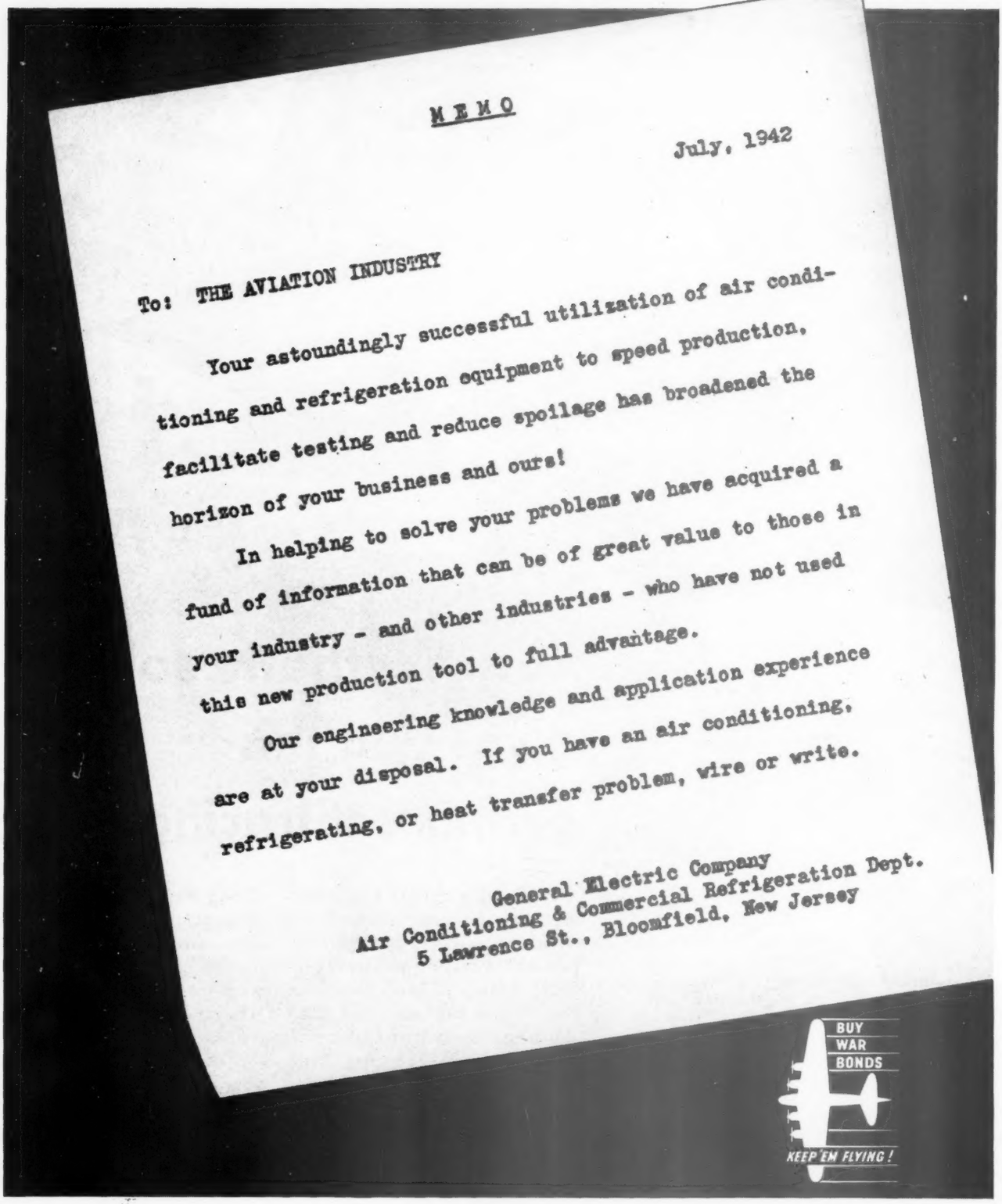
CHICAGO · ST. LOUIS · SAN FRANCISCO · LOS ANGELES

DETROIT · MONTREAL

K&E Albanene

REG. U. S. PAT. OFF.

THE STABILIZED TRACING PAPER

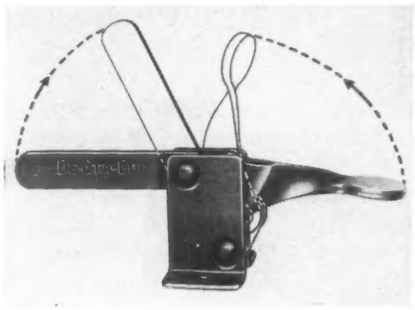

MEMO
July, 1942
To: THE AVIATION INDUSTRY
Your astoundingly successful utilization of air conditioning and refrigeration equipment to speed production, facilitate testing and reduce spoilage has broadened the horizon of your business and ours!
In helping to solve your problems we have acquired a fund of information that can be of great value to those in your industry - and other industries - who have not used this new production tool to full advantage.
Our engineering knowledge and application experience are at your disposal. If you have an air conditioning, refrigerating, or heat transfer problem, wire or write.
General Electric Company
Air Conditioning & Commercial Refrigeration Dept.
5 Lawrence St., Bloomfield, New Jersey
BUY WAR BONDS
KEEP 'EM FLYING!

GENERAL ELECTRIC

INTERCOOLERS · CENTRAL PLANT AIR CONDITIONERS · CONDENSING UNITS · MOTOR COMPRESSORS
DIRECT EXPANSION COILS · WATER COILS · EVAPORATIVE CONDENSERS

New Aircraft Clamp

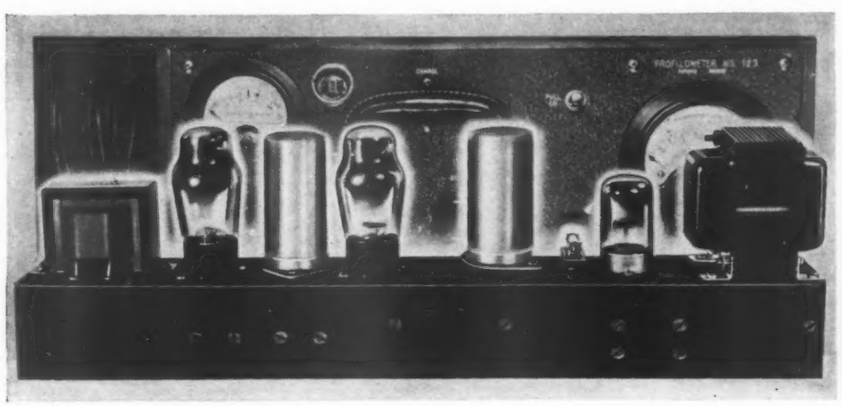
To meet aircraft demands for a small size, horizontal type toggle clamp, the **Detroit Stamping Company**, Detroit, Mich., have added a new model to their already large line of clamps. The most recent addition will be known as De-Sta-Co Toggle Clamp No. 205. When in locked position this clamp measures only 1⅞ in. high, and 5⅛ in. from tip of handle to tip of arm, weighs but 3⅛ oz.



Handle and arm are in horizontal position when clamp is locked, thus providing clear working space from above. Although small in size, the clamp design and type pivot pins used prevent any undue looseness of parts. Structure is rigid, yet clamp is always free and easy acting.—AVIATION, *July, 1942.*

Power Pack

A new accessory unit for use with Profilometers has been announced by the **Physicists Research Co.**, 343 South Main St., Ann Arbor, Mich. This unit, known as a Power Pack, has been designed to make possible the use of Profilometers on a.c. lines. Profilometers, instruments used for the measurement of surface roughness and providing direct dial readings in true inch units, until recently have been self-contained with batteries which permitted full portability. With the increasing need for their uninterrupted use in one location, particularly on three-shift inspection operations, the Power Pack was developed so that

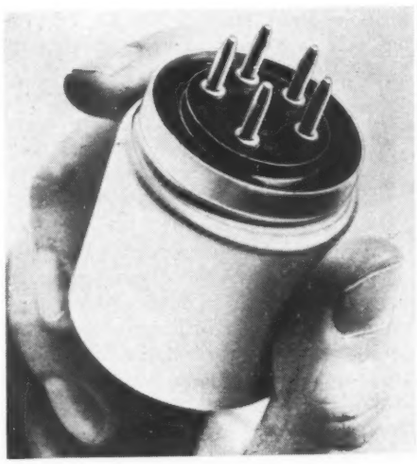


New Products

power could be supplied from a 115-volt 50-60 cycle a.c. source. Existing Profilometers having serial numbers of 75 or greater can be converted for a.c. operation by the installation of this new Power Pack, the instruments being returned to the Physicists Research Co. plant for this purpose. It can also be specified as a part of a new instrument. —AVIATION, *July, 1942.*

GE Sensitive D-C Relay

A new sensitive direct-current relay for aircraft service has been announced by the industrial control division of the **General Electric Co.**, Schenectady, N. Y. The relay, designated CR2791-C100C, is specially designed for use in vacuum



tube output circuits where the power available is so small as to require operation on extremely low currents. A sealed aluminum cover protects the relay from dust and against damage from rough handling. The relay is small and light in weight, weighing only 3¼ oz.,

Keep Tools Handy!

Penco Tool Handling and Storage Units

for 'Round-the-Clock Production

No. 37 TOOL UNIT
Heavy-duty—all welded steel!
3 Drawers—for 3 shifts

No. 34T TOOL UNIT
Portable, Protected Storage! All welded steel for parts, tools, gages, instruments

No. 39 TOOL UNIT
Plenty of work-surface! Open type or enclosed with doors—all steel

War Industries—write for details and prices

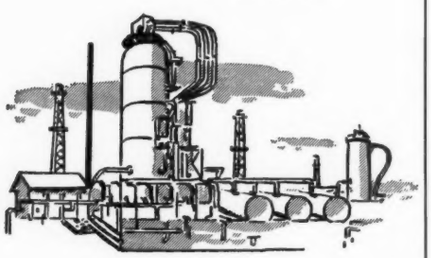
1869 Penco

Penn Metal Corporation of Penna.
In Business Continuously Since 1869
32 Oregon Avenue, Philadelphia, Pa.

WHY

Welded Stainless Tubing SPEEDS THE PRODUCTION of

★ SYNTHETIC RUBBER
★ GUNPOWDER
★ AVIATION GASOLINE
★ CHEMICALS



The *uniform wall thickness* of this tubing lengthens the service life of vital processing equipment such as heat exchangers, condensers, catalyst holders and pipe lines. (There are no "thin spots" to give deterioration a foothold.) Carpenter Welded Stainless Tubing is given hydrostatic, tolerance, surface and straightness tests to insure chemical and physical perfection in each length.

WHY designers & fabricators adopt this WELDED tubing

As tubing shapes are *natural design units*, parts can often be finish formed by merely bending, flanging, tapering or expanding. Then too, uniform tube walls permit the use of *lighter gauge* tubing where strength and rigidity are needed. As this lighter gauge tubing is *easy to form*, it helps to reduce rejects . . . even in the hands of semi-skilled workers.

Carpenter Welded Stainless Tubing meets U. S. Army & Navy "specs," and is available in random lengths, and lengths cut to exact size.

Carpenter's Welded Stainless Tubing Data Book is a handy reference tool for engineers and executives who want more information on applying and fabricating this tubing. A note on your company letterhead will start a copy on its way to you.

THE CARPENTER STEEL COMPANY
Welded Alloy Tube Division, Kenilworth, N. J.

Carpenter
WELDED
STAINLESS TUBING

and is designed to meet all Air Corps requirements set up for devices of this type. It has a maximum continuous current rating of 2 amp. at 32 v., and a maximum make or break rating of 10 amp. Maximum coil resistance is 3,000 ohm. The contacts provide single-pole, double-throw operation. — AVIATION, *July, 1942.*

Magnesium Fire Extinguisher

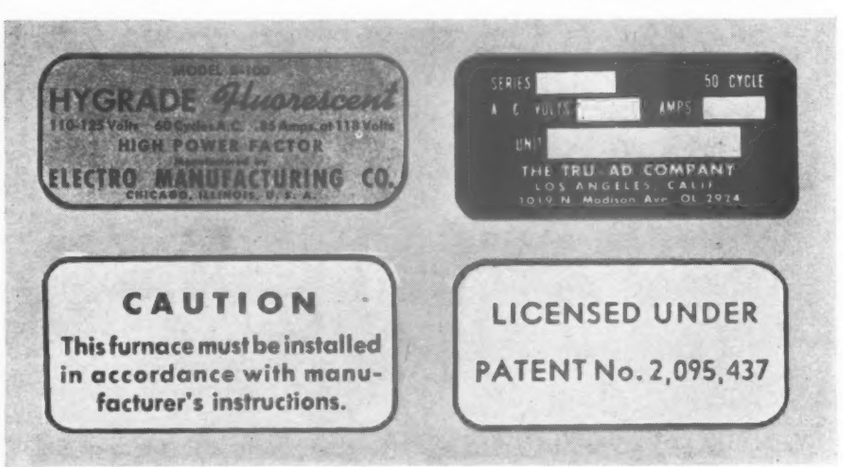
Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y., has just developed Magout Powder to easily and quickly extinguish magnesium fires. This highly effective powder instantly smothers fires caused by magnesium shavings in machine shops, or by magnesium incendiary bombs. It is a non-absorbent, finely pulverized dry powder, safe to handle and easy to use. Magout is available either in bulk quantities or in handy, instant-action tubes for sprinkling on fire. This is a new type cardboard container, spiral shaped for convenience in handling, with metallic ends and lined with paraffin. It is not only wise but safe to keep a quantity of Magout always in reserve for it is non-injurious and will not deteriorate.—AVIATION, *July, 1942.*

"Kum-Kleen"

Due to the conservation of all types of metal, many industries have found it necessary to use a substitute for name plates, metal tags, identification, patent number and instruction tags. A new product has been developed under the trade name of "Kum-Kleen" by **Avery Adhesives**, 451 East Third St., Los Angeles, Calif. This product is said to adhere permanently to any smooth surface including metals, glass, plastics, enamel, varnish, wood and is applied without moistening, and will adhere even when exposed to high temperatures or changing climatic conditions. They are particularly advantageous at this time as they eliminate the necessity of drilling, taping and riveting in application, yet have the permanent quality of metal tags, firm says.—AVIATION, *July, 1942.*

Oil Proof Aprons

A new line of heavy-duty, abrasion and tear resistant aprons which are immune to all oils and organic solvents, including insoluble sulphur-base cutting oils, is announced by **Resistoflex Corp.**, Belleville, N. J. The aprons are made of strong, pretreated fabric, heavily coated with flexible Resistoflex PVA material which retains the flexibility of the fabric base but renders it impervious to the chemicals and solvents encountered in a wide variety of industrial operations. The aprons afford protection against such widely used solvents as carbon tetrachloride, trichlorethylene, perchlorethylene, benzol, ether, chloroform, ethylene dichloride, paint and lacquer thinners, and animal, vegetable, and mineral oils of all kinds as well as carbon disulphide. They are available in 22½x35 in. size in the trans-

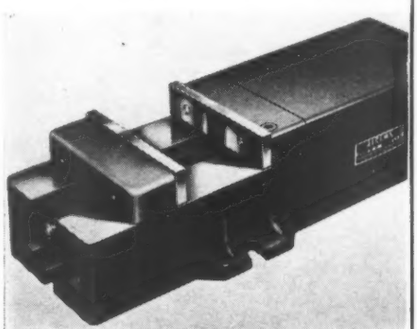


New Products

parent type, and 33x42 in. in the heavy duty type. The same Resistoflex PVA material is also used in the making of protective gloves as shown in the photograph. Both the gloves and aprons were developed as a protection against dermatitis and folliculitis, common skin infections which frequently occur from exposure to the sulphur-base cutting oils used in metal working industries or from exposure to other toxic solvents. Despite their strength and durability they are very light in weight, providing full freedom and comfort.—AVIATION, *July*, 1942.

Airlox Pneumatic Vise

This quick-acting production vise was developed by **Production Devices, Inc.**, 1169 Main St., E. Hartford, Conn., to meet the need for a tool combining the quick action of air with a positive grip on the work. It utilizes a single-acting air piston working through leverage which furnishes greater power to the movable jaw. By using an inexpensive trip valve, production is speeded up by synchronizing the opening and closing of the vise



jaw with the movement of the machine. Spring jig and special jaws, used with foot, hand, cam, air or electrically operated valves, speed up operation in milling, shaping, planing, broaching, drilling, tapping and assembling as well as on bench operations. Special features include: completely enclosed mechanism to assure freedom from chips, dirt, coolants, etc.; instantly adjustable jaw saves time; ground jaw faces, hole-spaced to your specification if desired; and special alloy castings for proven strength and uniformity. Specifications (Senior Model): Length overall 22⅝ in.; width overall 8½ in.; height overall 5 in.; weight approxi-

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Industrial CHEMICAL COMPOUNDS

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- ☐ Cleaning Prior to Plating
- ☐ Cold Immersion. Cleaning
- ☐ Cold Spray Cleaning
- ☐ Floor Maintenance
- ☐ Glass Cleaning
- ☐ General Plant Maintenance
- ☐ Hot Immersion Cleaning
- ☐ Magnesium Processing
- ☐ Paint Camouflage Cleaning
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- ☐ Phosphatizing
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mately 75 lb.; jaw width 7 in.; depth 1½ in.; Brown and Sharpe No. 4 jaw hole spacing, or to your specification; jaw travel ½ in.; maximum opening 7 in. between jaw castings; maximum air consumption .02 cu.ft. per operation; gripping force on work is 50 times air line pressure; higher gripping ratios with less jaw travel are optional at slightly additional cost. — AVIATION, *July, 1942.*

P & H Trav-Lift Cranes

Effective immediately, the **Harnischfeger Corp.**, Milwaukee, Wis., announces that Trav-Lift cranes will include two added features as standard equipment. All double I-beam cranes employing a motor driven trolley will be equipped with a drag brake on the trolley. All cage controlled Trav-Lifts will be furnished with a foot gong. Formerly, these accessories were available on special order only. P & H Trav-Lift cranes are made in capacities up to 15 tons, and are ideal for intermittent service, and for supplementary usage with the large overhead traveling cranes also manufactured by Harnischfeger. An illustrated bulletin indicating how Trav-Lifts can be used to speed production in many war materials plants, with safety and economy, is available on request. Write for Bulletin H-13.—AVIATION.—*July, 1942.*

New Products

Avery Adhesives

A new type sticker is being widely used in the electrical field to identify wires for installations, carry instructions, warnings, patent numbers and manufacturer's identification. These new stickers are manufactured by **Avery Adhesives**, 451 East Third St., Los Angeles, Calif., and are applied without moistening; permanently adhere to any smooth surface; never pop off, even under extreme heat or humidity, yet may be easily pulled off without leaving a mark. They are available blank or printed to specification.—AVIATION, *July, 1942.*

FIRST

Since the Birth of Aviation

1923·First Army Hawk, 420 h.p. Flown by Lt. R. L. Maughan in first coast-to-coast, dawn-to-dusk flight—150 m.p.h.

1929·Six years of development finds this P-6 Hawk with greater horsepower—625—and many improvements.

1937·Retractable landing gear (a 1933 development on the Navy Hawks), a speed of over 300 m.p.h., a 1100-H.P. engine, were among the notable advances on the P-36 series.

1941·Since the production of the original P-40's, this famous series has undergone four successive "step-ups" to new high performance levels in speed, ceiling and striking power.

WARHAWKS *for Victory*

From the start, Curtiss P-40's have been in the thick of nearly every important air combat the world over. Back home, without a halt in desperately needed production, these famous fighters have undergone many successive step-ups in performance. Now a still greater P-40, the Warhawk, with its hard-hitting fire power, will soon be winning new victories in America's march toward all-out air supremacy.

SECOND PRINTING

Send 10¢ for your copy of this fascinating 96-page history of aviation by Assen Jordanoff, author of "Your Wings", with illustrations of current fighting types. Curtiss-Wright Airplane Division, Curtiss-Wright Corp., Buffalo, N. Y.

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Corporation
AIRPLANE DIVISION

On Land and Sea Beechcrafts Are Doing Their Part

U. S. AAF AT-7A BEECHCRAFT Advanced (Navigation) Trainer equipped with Edo Floats for Special Service

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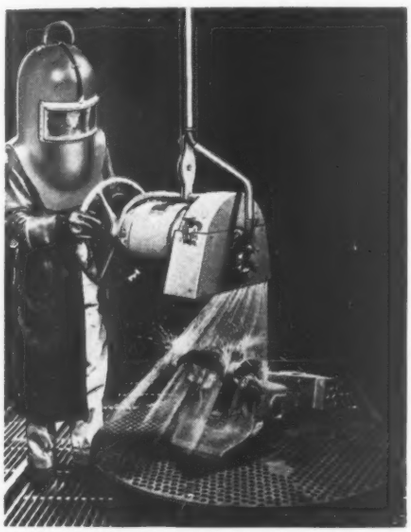
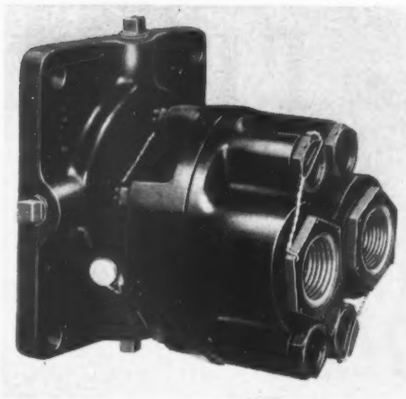
Portable Wheelabrator

A Portable Wheelabrator for the blast room has been announced by **American Foundry Equipment Co.**, 555 S. Byrkit St. Mishawaka, Ind. The unit is suspended by means of a cable which connects with a spring balance so that it can be raised or lowered with ease. The balance, in turn, is mounted on a carriage that is free to move on a radial track to any point in the blasting area. Abrasive (metallic shot or grit) is fed to the wheel through a pipe



from an overhead storage hopper. The pipe is arranged with universal couplings to permit complete flexibility to the blasting unit. Operation of the wheel and the flow of abrasive are regulated by convenient controls. Being airless, the new blast unit eliminates such equipment as: air compressor motors, pressure tanks, mixing chambers, air receivers, piping, hose, valves and nozzles. It is claimed that the Portable Wheelabrator has been successfully applied to the cleaning of a wide range of large and small intricate, irregular-shaped work such as that handled in jobbing shops or where the daily production of various parts does not warrant the use of special equipment. Typical applications would include such work as: lathe beds, flywheels, gears, pulleys, valves, car wheels, frames, housings, etc.

The Portable Wheelabrator has complete flexibility of movement to any position—high or low—in any direction, and to any part of the blast room. Powered by an electric motor (direct connected of 2 hp., 3 phase, 60 cycle, a.c., 3,600 rpm.; overall dimensions are length 26 in.; dia. of motor housing 12 in.; max. width of housing 18 in.; dia. of handwheel 17 in.; amount of abrasive handled per minute—approx. 70 lb. at normal rated capacity; net weight: approx. 230 lb.—AVIATION, *July, 1942.*

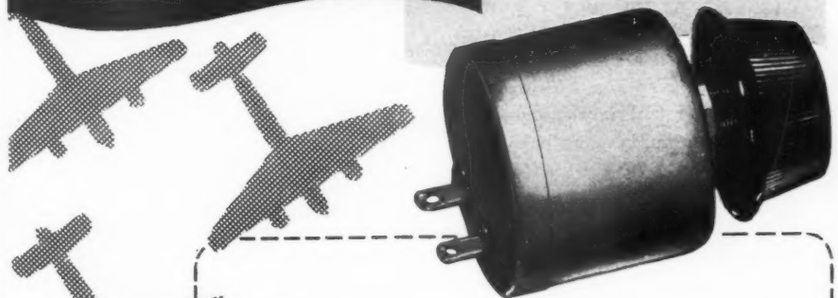


Pesco Hydraulic Pump

A new line of "pressure loaded" gear pumps has been developed by **Pump Engineering Service Corp.**, 12910 Taft Ave., Cleveland, Ohio, in which some of the available models are suitable for continuous operation at 1,500 psi. The term pressure loaded means that the bushings within the pump are held against the gear faces by hydraulic pressure, thus reducing the end clearance to a minimum, and resulting in unusually high volumetric efficiencies. Designed to meet the needs of modern aircraft for a hydraulic pump with efficiencies equal to those of reciprocating piston pumps, but with better high altitude performance and simpler design, this new unit offers the following advantages: (1) Ability to operate with either A.C. 3580 (Univis No. 40 or the new light S.E.A. No. 34 (Univis No. 34) oil with equal efficiencies; (2) elimination of need for exacting methods of servicing and assembling, since end clearance is not a factor of efficiency; (3) extremely long life without servicing since all wear is automatically taken up during the life of the pump; (4) minimized maintenance cost due to long life and elimination of exacting methods of field assembly; (5) elimination of seal leakages by the use of a positive seal on the driveshaft. Other features include ability to operate at temperatures as low as 70 deg. F. due to automatic adjustment of end clearances of gears and high volumetric efficiencies at speeds as low as 600 rpm. Eight models are available, comprising a complete line of Air Corps type pumps, in sizes from ½ to 3 gpm. at 1,500 rpm.—AVIATION, *July, 1942.*

OHMITE
Rheostats

Insure Smooth, Close Control...



Ohmite Rheostats were the first to be used in aircraft—and have been first ever since. Today, more Ohmite Rheostats are used in military and commercial airplanes than any other make. Special Ohmite features insure smooth, close control and utmost dependability. Approved types for all Army and Navy specifications.

Write on company letterhead for helpful 96-page Industrial Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING COMPANY
4945 Flournoy Street, Chicago, U. S. A.

BE RIGHT WITH ★ OHMITE
Rheostats · Resistors
Tap Switches

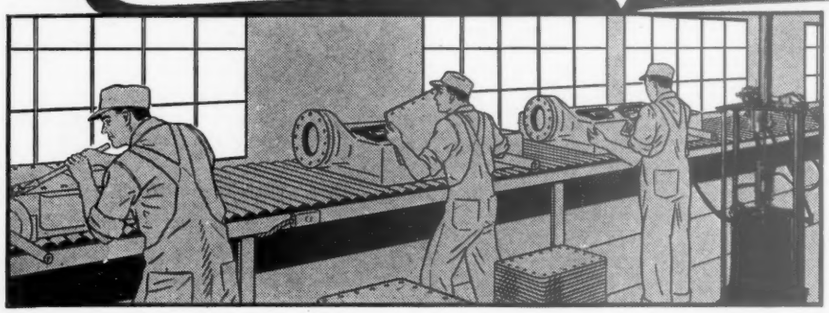
Speed up PRODUCTION

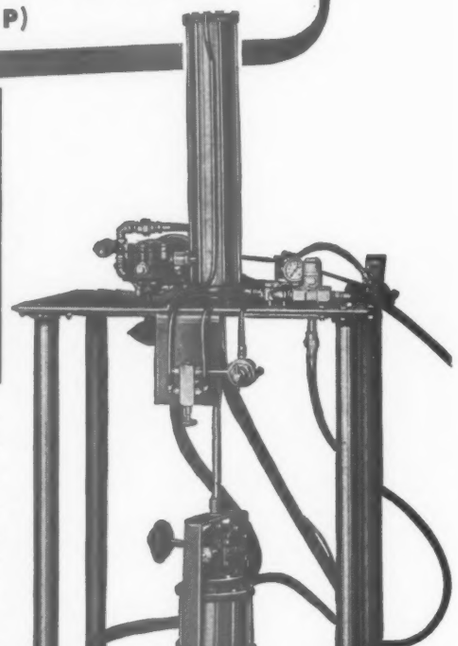
ON YOUR ASSEMBLY LINES—

DISPENSE INSULATION, CAULKING COMPOUNDS AND SEALING MATERIALS *with the*

LINCOLN "PILE DRIVER"

(FORCED-INDUCTION PUMP)





WITH production surging to new highs, the men responsible for keeping schedules on the increase are searching for short cuts and time saving equipment.

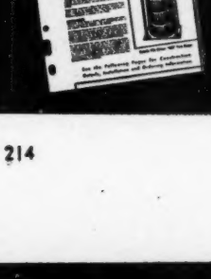
Lincoln engineers have recently perfected the Lincoln "Pile Driver." This unique pump is designed to dispense heavy viscous materials such as sealing compounds, sound deadeners, insulating materials, putty, heavy lubricants and other substances too heavy and solid to prime in any other type of pump.

Many of these units are now in service—on production lines where bearings or gears must have initial lubrication—in processes where assemblies must be sealed before riveting—in the production of special war products that must be gas and dust tight—in the refrigerator industry to apply sealing and insulating materials, etc.

Because of the ability of the Lincoln "Pile Driver" to deliver heavy materials direct from original containers to the point of application, this unit saves many man hours and material. Its use does away with the old stuffing-by-hand, putty-knife and paddle methods of the past and speeds up production. In some cases, one man with a "Pile Driver" can do the work that formerly required several workers when the old methods were used. This saving alone will pay for the equipment in a short while.

Lincoln "Pile Drivers" are available in single or two-stage models, both employing the famous Lincoln Air-Motor. Two sizes can be furnished—the "100" for pumping materials from containers up to 10-gallons (100-lb.) and the "400" for pumping materials from 55-gallon (400-lb.) drums. Each can be arranged as a single stage or a two-stage unit depending on the requirements. The delivery of material is controlled, in both models, by a hand-operated shut-off valve at the outlet, and the flow is always under control of the operator.

BULLETIN 661
describes the Lincoln "Pile Driver" and will be sent upon request.



Special Engineering Service

These new pumps can be adapted to a wide variety of applications. Lincoln industrial engineers will gladly lend their knowledge and make recommendations as to how the "Pile Driver" can serve you.

I42-11

LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

ST. LOUIS, MISSOURI, U. S. A.

Speedgrip-Automatic Wrench

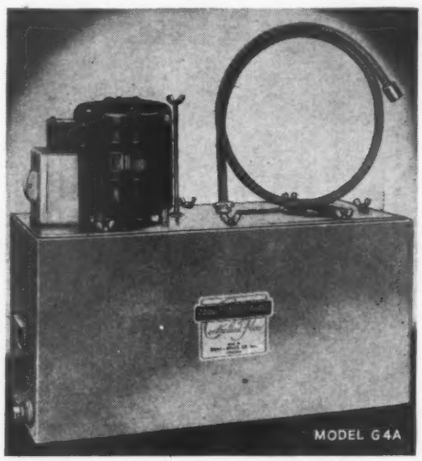
The **Pack-Rite Machine Corp.**, 828 North Broadway, Milwaukee, Wis., announces plans for manufacture of the Speedgrip-Automatic Adjustable Nut Wrench patented by G. F. Schlote, who will also be active in its production. This ingenious wrench boasts lightning adjustability to any size nut or bolt by merely flashing the handle-band up or down on the handle shaft. The vice-like grip of the jaws is self-locking;

cannot slip because of its unique construction; and increases its strength when operated on larger size nuts or bolts. Will not bind when released; zips into position in a flash; operated with only one hand; will be manufactured in nut and pipe wrench types in four different sizes.—AVIATION, *July, 1942.*

Gray Coolant Pumps

Three new larger capacity Gray Portable Coolant Pumps for automatic application of coolants to cutting tools are announced by the **Gray-Mills Co.**, 213 W. Ontario St., Chicago, Ill. The new models, designated as Heavy Duty, "A" series pumps G-2A, G-3A and G-4A, like the original "G" series, are designed to prolong tool life, speed up production and lower operating costs.

Features of Heavy Duty "A" series coolant pumps are complete portability, controlled flow from a few drops to full stream, baffle plate construction and forced settling fixture to keep coolant fluids clean at all times (especially advantageous for abrasive grinding, milling and honing machines), larger tank capacity (10 and 12½ gal.) to eliminate frequent coolant changes, ball bearing type motors, easily replaced driving gears hardened for long wear, cleanout plug for quick and easy tank cleaning, flexible power shaft coupling,



and easy access to all working parts. On machine set-up requiring four to six points of coolant application, each has its own coolant flow regulator.

Standard machine working tables may be adapted to coolant pump use with specially designed "Flo-Bac"

pans, Flo-Bac fittings consisting of lead-off pipes, fittings, clamps, flo-control valves and flexible tubing permit permanent and easy attachment to single and multiple spindle drill presses. They insure rigidity of mounting and positive application of coolant to tools. —AVIATION, *July, 1942.*

Mu-Switch Gets AAF Approval

The Mu-Switch Corp., Canton, Mass., announces full approval of Army Air Forces, under Specification 94-32249, has been granted on their Aircraft Type Switches AC-101-GB (normally open), AC-101-RB (normally closed), and AC-101-BB (single pole, double throw). See description New Products Section, Page 158, AVIATION, June 1942.—AVIATION, *July, 1942.*

WINDOW SHOPPING

Airport Lighting—For use in airport lighting design, a new 42-page bulletin is announced by Westinghouse Electric & Mfg. Co. Covering all the lighting and electrical distribution equipment involved in the design of an airport, the bulletin was prepared in collaboration with the CAA and has its full approval. Typical layout plans with CAA recommendations are given for airports with runways of from 1,500 to 4,500 ft. Special feature of the bulletin is full-size black and white photostats of typical lighting wiring diagrams for the four airport classes. Copy of bulletin B-3046 may be secured from department 7-N-20, Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

The Care of Gage Blocks—A 4-page booklet which reveals up-to-date methods of increasing the usefulness and life of gage blocks. During these times when there is a shortage of gages and precision tools every toolmaker and mechanic who works with precision length standards can gain information from this study. Copies may be obtained upon request from the George Scherr Co., 128 Lafayette St., New York, N. Y.

Addressograph Methods—An interesting and detailed brochure describing the part played by Addressograph methods at the Sperry Gyroscope Co. in centralizing the issuance of manufacturing information and simplifying the control of work in progress is available on request to Methods Department, Addressograph-Multigraph Corp., Cleveland, Ohio.

General Controls—A new line of aircraft type electric valves which resist vibration and change of motion as well as operate in any position, is completely described in a bulletin, No. S-304, just issued. The new valves, known as the AV Series, handle all liquids, gases and vapors at pressure from 0 to 1,500 lb. or more. Standard line includes normally open, normally closed, and relief valves, supplemented by 3-way and 4-way selector valves. General Controls Co., 801 Allen Ave., Glendale, Calif.

Capillary Air Conditioners—Bulletin G-2 describing the capillary cell and its application in air conditioning equipment as a direct heat transfer surface between water and air. Book outlines the functions of the cells for cooling and dehumidifying, humidifying, air cleaning, evaporative cooling, condenser water cooling, fume absorption, etc. Engineering and performance data are presented in convenient tabular and graphic form for the use of the engineer in determining capacities. Air & Refrigeration Corp., 475 Fifth Ave., New York, N. Y.

Wings of Victory—Interesting illustrated booklet on military aviation, including plan view silhouettes, squadron insignia and brief histories of army-navy aviation. Published by Berry Brothers, Inc., Detroit, Mich.

Bassick Floor Truck Lock—Illustrated folder on a positive position lock to keep floor trucks in place without expensive caster brakes. The Bassick Co., Bridgeport, Conn.

Industrial Rubber Conservation—A 48-page illustrated book on conservation of rubber products in industry has been published by U. S. Rubber Co. Rubber products now in use by manufacturers are essential to war production and will become increasingly difficult if not impossible to replace. Complete and explicit suggestions are given for the proper care of these important products from initial design through inventory and storage to use, maintenance, inspection and repair. The book, *First Aid to Industry in Conserving Rubber*, is completely indexed and all mechanical rubber goods are included. Copies are being mailed immediately to more than 50,000 engineers, plant managers, superintendents and others responsible for production and maintenance in American industries in all parts of the country, and other copies will be available on request. Publicity Dept., U. S. Rubber Co., Rockefeller Center, New York, N. Y.

An-cor-lox Lock Nuts—New lock nut is fully described in the folder, replete with diagrammatic, photographic and factual matter on An-cor-lox styles, materials, designs and finishes; application instructions; and suggestions for parts conversion to the An-cor-lox function. An-Cor-Lox Div., Laminated Shim Co., Inc., 86 Union Sq., Glenbrook, Conn.

CONNECTICUT
BITS and PIECES
SYNTHETIC RUBBERS
BUT these bits and pieces have a tough assignment. No stock compound can give them the physical characteristics they need in actual combat.
Some must resist high aromatic gasoline, some must remain flexible at —60° C, some must retain a high tensile in the presence of hot oil, and some must adhere firmly to steel, brass or aluminum. And when we make them, they do it.
Our pieces do as they should because our research staff knows how to build up a compound from the best synthetic for the job. In other words, it is custom made with no strings attached and no effort spared.
For Victory
We are busy, of course, but if it will help win the war we will find a way to do it.
THE CONNECTICUT HARD RUBBER COMPANY
NEW HAVEN, CONN.

"It CAN be done!"

With this war-cry, plus the ingenuity and persistence of a few typically American exponents of the "do-it-now" school, Scott Aviation Corporation—a few years ago but a part-time basement machine shop—is in quantity production of delicate aircraft instruments.

THE SCOTT ORGANIZATION began in 1932 as the Universal Alloy Products Company, a part-time activity of Earle M. Scott, who, utilizing experience accumulated as a private pilot, had designed a tail skid shoe for light aircraft. Wholesale buyers of this first product asked for a wheel to replace the shoe and in 1935 Scott designed and developed the first attachable tail wheel assembly for light aircraft, supplying these in quantities to aircraft manufacturers and operators with the assistance of from one to six part-time employees, in a basement and garage workshop.

In 1940 business warranted Scott's full time. Early in that year he was joined by R. D. Pollock, then with the M & T Trust Co., as treasurer of a new company, Uniloy Accessories Corporation. Employment then, still in the basement of 114 Pleasant Avenue, Lancaster, N. Y., was five full-time and six part-time employees.

Mr. E. C. Prior joined the organization as secretary in 1940 and early in 1941 was actively engaged in sales and in procurement west of Buffalo, N. Y.

By the fall of 1940 the basement was outgrown. Uniloy built a 75 ft. by 35 ft. building at Lancaster for the manufacture of aircraft tail wheel assemblies, aluminum alloy castings and a growing list of aircraft accessories.

Development work with the light plane manufacturers had resulted in the conversion of a number of formerly "welded-up" steel fittings and assemblies, to aluminum castings. A "space-saver" for the storage of light aircraft had been designed and successfully marketed; a control-wheel had been designed and marketed also, along with other original aircraft accessories. Negotiations with the British Air Commission resulted in a large order for a special accessory used on bombers.

Early in 1941, the British Air Com-

★ "YOU'RE TOO DUMB TO KNOW WHEN YOU'RE LICKED," is in effect, what some pretty important men told members of the Scott organization on several occasions last year. Well, if these important men happened to be right, all that can be said is that we need a lot more dumbbells to help win this war in a hurry.

Earle M. Scott, inventor, engineer and private pilot, had a basement machine shop and limited experience in producing a light plane tail wheel assembly which he developed. Two years ago, Scott still had only a handful of men in his basement. In the fall of 1940, a small building was erected. In 1941, orders came from the British Air Commission and, later, from the Army Air Corps.

Military secrecy makes it impossible to divulge the nature of the products or number of employees. But in a four-month period Scott multiplied already expanded personnel by ten times, trained green men and women to inspect parts, assemble and test fine mechanisms having 132 individual pieces, all of which were subcontracted over a 1,000 mi. radius.

Scott and his associates had to find and educate subcontractors. They had to see that they got tools, machinery and materials. They had to "push, pull, kick and holler" until schedules were met. When it was discovered that an urgently needed vibration-testing device was nowhere available as a standard unit in the United States, Scott designed and built one and had it ready for operation in a few weeks time. When a subcontractor fell down on deliveries, they virtually made the parts by hand until another supplier was located.

So it went. As a result, deliveries were double the schedules in the second month of production and Scott attained maximum expected production in two months instead of four.

To tell these men a thing can't be done, or a machine can't be had is simply a taunt which stings them into action to prove "it *can* be done." It is this attitude coupled with the imagination, ingenuity and determination required to supply the missing links from materials at hand, multiplied by millions, which is going to "keep 'em flying" until democracy's victory.

Earle M. Scott got started in the aviation business in this machine shop in the basement of his home.

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mission, because of the excellent results shown in Scott's production asked him to bid on an order for a very intricate mechanism needed in quantities—quickly. Few manufacturers were capable of completely manufacturing the 130 intricate parts required, and these were already filled to capacity with orders for similar equipment. The Scott organization suggested that it be allowed to bid, and find machine shops to act as subcontractors to provide the parts, Scott being responsible for the entire job including the very involved assembly, and the strenuous and lengthy test procedure. The advent of the Lend-Lease Bill brought the Army Air Forces into the picture as the purchasing agency. Scott was able to convince them also that the subcontracting plan was feasible. All this was *before* Uncle Sam was pleading with prime contractors to use subcontractors' facilities. A contract for this equipment was awarded, early in the summer of 1941.

New buildings already planned were immediately started and occupied by midsummer.

A capable engineering staff, including instrument technicians under H. A. Benzel, formerly of the Buffalo Aeronautical Corp., was immediately set to work to convert the British instrument to American standards and American methods of production.

A purchasing agent, E. J. Allein, formerly with the Bell Aircraft Corp., and conversant with contract machining procedure spent weeks contacting potential subcontractors, locally and far afield. (Four parts are being made to Scott blueprints in a machine shop in North Carolina.) All parts that could

ABOVE: Another view of machinery and airplane parts in Scott's original basement machine shop. BELOW: It grew to this in a couple years time and this present building is again being enlarged to handle new contracts.

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We also are proud that we were ready to accept the responsibilities given to us. Our pledge is to so serve, now, that you will want us to serve you when America has won its victory.

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be made locally were secured in Western New York.

Other manufacturers of parallel equipment gave freely of their counsel and advice, and were very helpful. Tap and threading-tool manufacturers were very cooperative, but threw up their hands in despair when told that a dozen different machine shops, scattered over a 1,000-mi. radius would make mating parts, and that these parts must all reach the Scott plant with matching fits, to strict specifications. But they all pitched in and did a marvelous job. One expert bet an officer of the company $10 that Scott could not get into production six months after the last tools were supplied. Actually, they were in production one month after arrival of the last tool, after being held up several weeks by a subcontractor's strike.

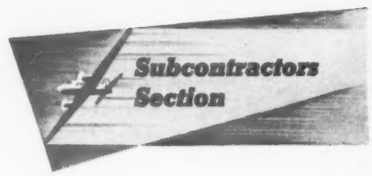
December 7, found Scott just beginning production. The advent of war forced the Army Air Forces to ask for greatly accelerated delivery. By working 24 hours a day, 7 days a week, with virtually every member of its organization, Scott in December, 1941, shipped every unit requested; ten times in volume what it had contracted to do in its first month of production.

Production requires constant engineering attention, but in addition some of its engineering staff are developing other oxygen instruments and allied equipment for aircraft manufacturers and the Army Air Forces.

The company executive organization is composed entirely of young men whose ears are to the ground on potential post-war business.

In February 1942, it was considered necessary to change the name Uniloy Accessories Corp. to the Scott Aviation Corp. due to the fact that "Uniloy" was found to be a copyrighted trade name for a type of steel.

A majority of materials for Scott war



production are received as finished or semi-finished parts, made to blueprints and specifications furnished. One complicated assembly requires 132.

Parts are received, counted, and delivered to an inspection department which is completely equipped with thread gages, go and no-go gages, optical inspection devices for close visual inspection, torsion-testing equipment for testing control knobs, and the usual complement of depth gages, micrometers, etc., normal to an inspection department.

Every part receives a visual inspection; threaded parts are gaged with plug or ring gages. Checks are used to maintain gages. Threads are held to a Class 3 fit. All critical dimensions are checked on every part, to assure perfect assembly on the assembly line. A few parts are given Air Forces inspection in the subcontractor's plant. A salvage committee daily inspects all rejected parts. Those which will pass inspection by rework are sent to the machine shop in the next department. Every effort is made to rework all rejects in the Scott plant, to prevent the costly delays when parts are returned to a subcontractor. The subcontractor is constantly impressed with the fact that Scott will rework a reasonable number of rejects, but that if rejects continue orders must be placed elsewhere.

After inspection and acceptance all parts go to one of several finishing operations, some in the plant, some outside, for anodic treatment, spray-painting, plating, de-greasing, etc. Every

Photo by M. G. Schneckenburger

An assembly line in the efficient new plant of Scott Aviation Corp.

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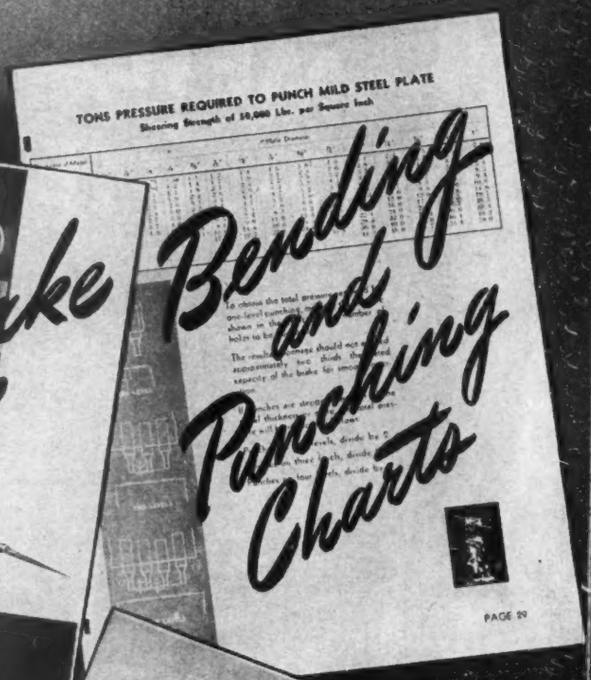

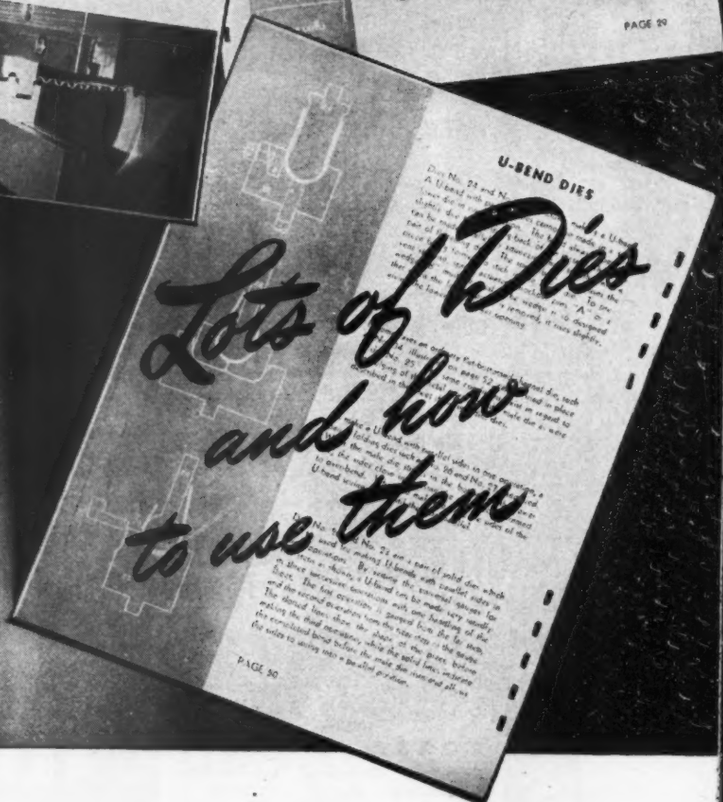

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part is thoroughly de-greased before assembly, in a solvent de-greaser. Several parts require testing at pressures as high as 2,400 lb./sq.in.

When finishing treatments are completed all parts are received again by the inspection department, re-inspected, and delivered to parts stores. Then they move from parts stores to sub-assembly, to final assembly, to test.

All of Scott's subcontractors have been supplied with threading tools, thread gages, machine tooling, jigs, fixtures, etc., loaned for the duration of the contract. Additional tools, drills, etc., are furnished as replacements when needed. Materials are either furnished to the subcontractor or, when necessary, assistance given for their procurement.

Seemingly insurmountable obstacles have been overcome due to the fine teamwork of the organization and the hustling cooperation of its subcontractors; Scott men have spent days and weeks in subcontractors' plants, coaxing, pushing, helping, and sometimes with the assistance of governmental departments, almost forcing early manufacture and delivery of wanted parts.

Initially, as quickly as new parts were received, these parts were assembled into already-received parts, so that first production began only a few days after arrival of the last parts.

Then the lights burned early and late in the Scott plant while engineers sweated over some new "bug" to iron out—a manufacturing problem, an assembly problem, or a testing problem with a temperature of —40 deg. C., vibration test of 20-hr. duration or a hydraulic test at 2,400 lb. pressure. They had to beat it, or bombers being manufactured and ready to be flown could not fly.

Some subcontractors fell by the wayside; unable to produce parts to the necessarily close specifications. But subcontracting substantially *has* proven feasible.

Scott Aviation Corp's. success in producing in quantity intricate instruments, within six months from the date of their contract, using virtually all subcontracted parts, is proof that the "bits and pieces" system of producing for Victory can be made to work. It is a matter of regret to them that they cannot, due to restrictions, publicize their subcontractors.

It was necessary that Scott's personnel be greatly expanded, and the employees had to be found in a labor market already combed by a dozen aircraft and munitions manufacturers. Harold F. Whittaker formerly with the DuPont Company and later with New York State Employment Service, was placed in charge of employment. He is now Scott's personnel (and production control) manager. The fine staff is a tribute to his personnel-picking ability.

Few were highly skilled when first employed, but careful and painstaking coaching, together with clear explanations of both the use of tools and equipment and, even more important, a full knowledge of their importance in National Defense has resulted in the deepest sense of obligation to do their part of the job.

A class in personnel and supervision has been formed and has met all during the winter of 1941-1942 with excellent attendance. A class in physics started as a means of providing a better understanding of instrument mechanics is being attended by nearly 25 percent of the employees.

Labor relations have been excellent. Overtime has been accepted with a smile. On one occasion, to fulfill an urgently-needed delivery, in December 1941, one department worked 22 hours without leaving the plant, then returned after 5 hours to finish the job. On another occasion they donated overtime pay to the Red Cross.

Employees have six 5-man, and three 5-girl bowling teams, bowling once weekly, for a trophy, company-donated. Employees, in response to the War Bond appeal, are purchasing an average of $15 in bonds per month on a payroll-deduction company-participating plan.

Men and Machinery Available for War Work

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Aviation will continue to forward inquiries of both classes of potential contractors to firms requesting additional data.

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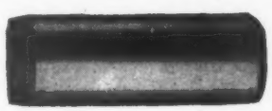

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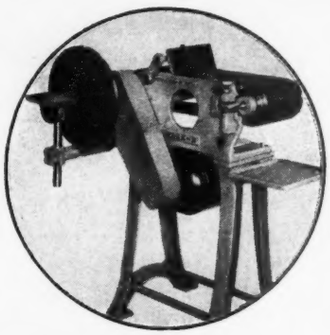

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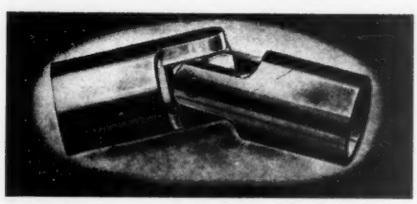

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113. Auburn, N. Y.—Grinding company has, in addition to turning, milling and drilling equipment, high production surface grinder capable of accuracy to plus or minus .0002 in.

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117. Chicago, Ill.—An engineering and manufacturing organization, now

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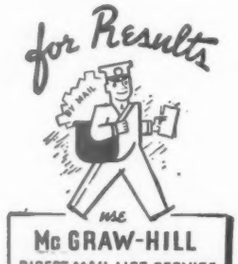

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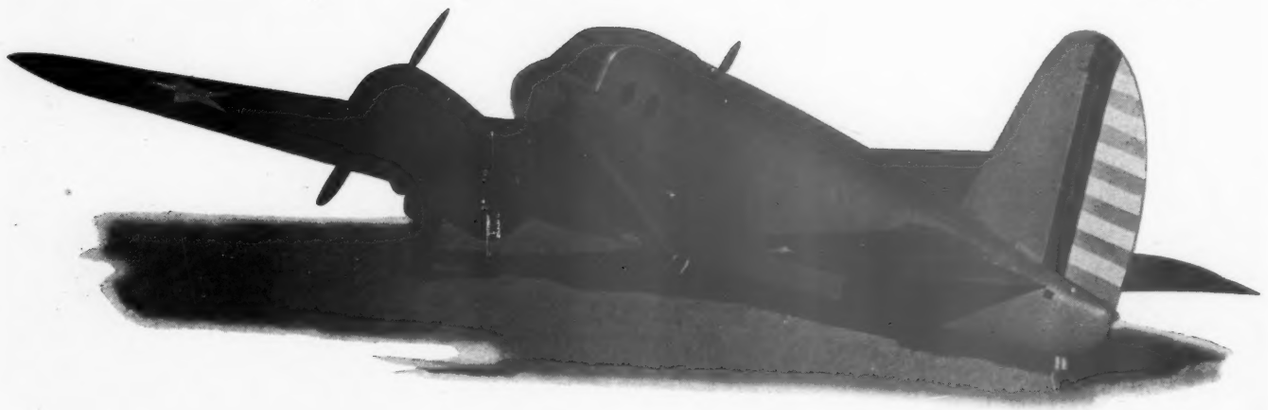

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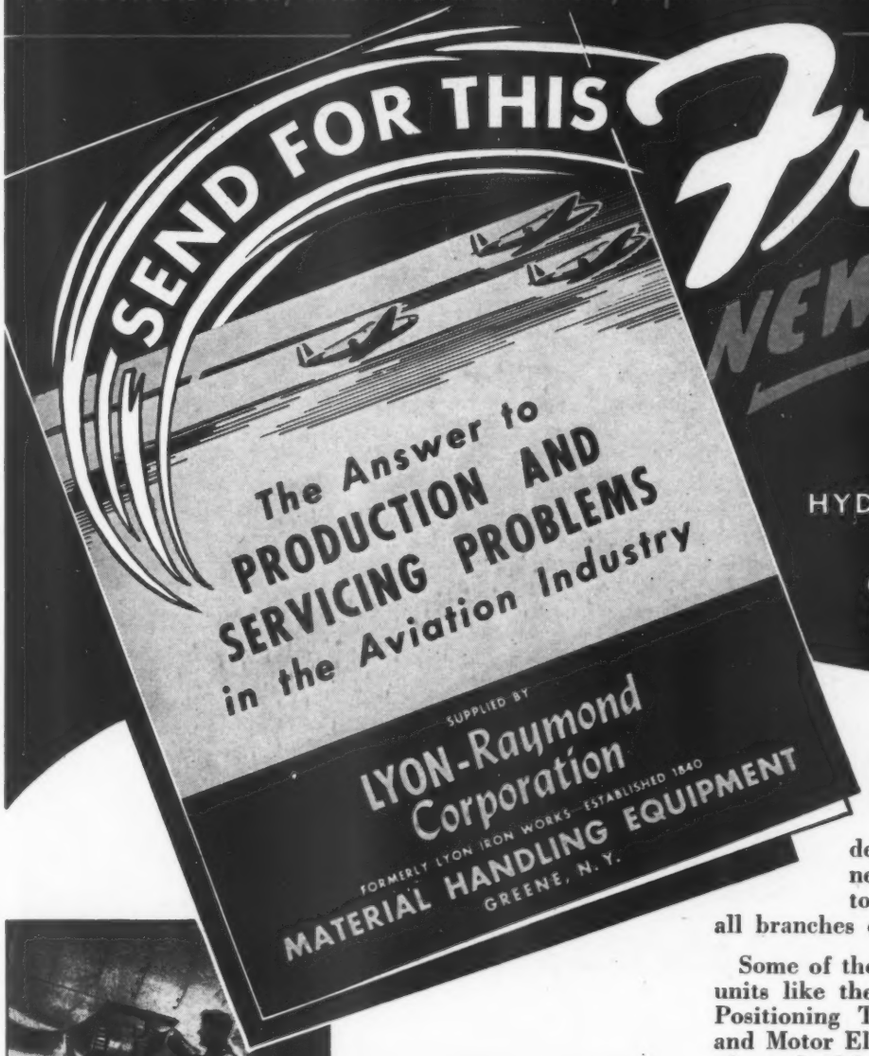

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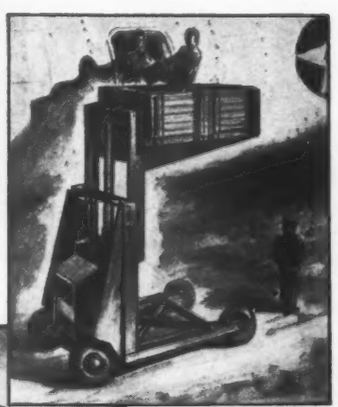

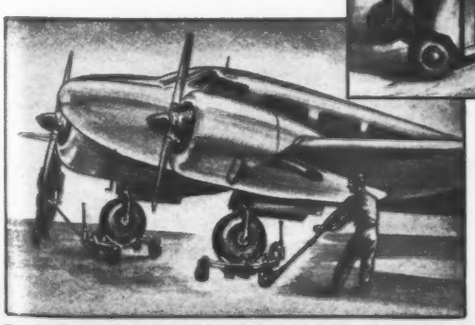

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"SIGHTED SUB—SANK SAME" . . . This recent radio report coming from one of our naval patrol planes represents today's version of Perry's famous line, "We have met the enemy and they are ours."

The vast expansion of our air forces as well as the mounting orders for barrage balloons naturally call for the use of much cotton fabric.

B★A★30 AIRPLANE CLOTH and WARWICK BALLOON CLOTH both play an important part in the equipment and protection of our armed forces.

WELLINGTON SEARS COMPANY • 65 Worth Street, New York, N. Y.

Cottons FOR ~~*DEFENSE*~~ *OFFENSE*... WELLINGTON SEARS FOR *Cottons*

Side Slips

• A LONG TIME AGO—when air transport was still scaring people's livestock—the *Saturday Evening Post,* or one of the big magazines, had a humorous picture of an airplane flown by a farmer loaded with potatoes, pigs and cabbages.

These commodities were stacked all over the wings; the airplane had a front end like a truck, with a crank; the pigs were squealing; and the farmer was smoking a corncob as his whiskers floated back in the wind.

What the story with this picture said, we don't remember, but we ourselves wrote a droll piece, poking fun at people who were beginning to think someday they could fly saw-logs and baled hay. And the magazine we wrote it for borrowed that flying truck picture to illustrate what we said.

Well, we predicted wrong, but we had a lot of company. Now it's almost here—will be, soon as Adolf Schickelgruber's hide is on the fence. There are cargo planes behind walls and in blueprint file cabinets now that would carry 25 truckloads of hogs, or what have you.

What most people forget is that you can take the same money it costs to build ships, or railroads and rolling stock, or highways and motor vehicles, and build airplanes, and because the planes can make so many more trips, they will pile up more load at the end of the line, in a given period, than the other transportation can.

At least that's the way things appear to add up now. If the war lasts you may see China supplied by air, and England to a large extent. In time the submarine could be as out-of-date as a blunderbus. You might see whole armies go aloft, with all their shooting irons and supplies.

If you're feeling bored and tired out, try to perk up and live to see what gives in the next ten years.

• THE STEEL INDUSTRY has something it calls "scrambled facilities," which means they own part of their plants and the government owns part, and only the CPA's and the RFC's auditors can tell *which* part. Now the aviation industry has scrambled facilities too, only more scrambled than—look, it's practically eggnog. We've noticed lately that the people who started making airplanes and engines 10, 15, 20 years ago, have been obliged to call themselves the "old line" aviation industry, so as not to get mixed in with the people who started a year ago.

Now we are no corporation organizer, or any sort of expert, but our journalistic intuition tells us that this old line expression is not going to work. Why, some airplane companies are making other companies' airplanes; some automobile companies are making airplane engine companies' engines—and airplane companies' airplanes; the government owned part of the old line people's plants before the auto people came along, and now we suppose the government owns, or has a mortgage on, some auto plants which are making airplanes for airplane company plants which belong to the government.

We have been looking forward anxiously to see whether any airplane companies would make cars, but now we fear we'll never know who's doing what for which—unless one of those Harvard lawyers in Washington could figure it out. Boy, send a wire and get us a Harvard lawyer.

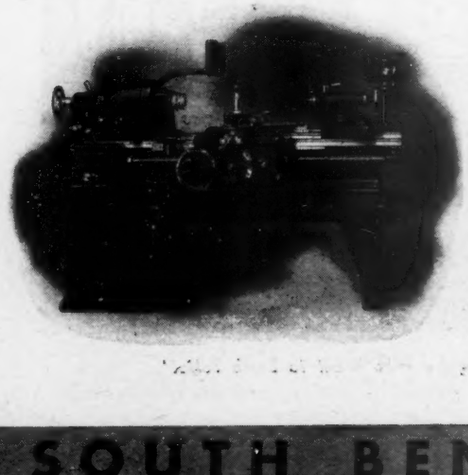
• WHEN REPORTERS ASKED the President where the Doolittle bombing raid on Japan started from, he replied that it came from Shangri-La. In case you don't know, Shangri-La is a purely mythical place in James Hilton's novel, *Lost Horizons.* When a German news service picked up this remark of Roosevelt's, it added that the American President declined to say where Shangri-La was.

"Here's a Thousand Guys Named Maguire Who Want to Bomb Tokio!"

TOOLING FOR WAR PRODUCTION

Back of the plane and tank and gun — back of our entire war program — stands the man behind the machine. In the toolroom of a large aeronautical plant this craftsman at a South Bend Lathe is doing his part in defending America.

The Man Behind – the Man Behind the Gun!



IN TIME OF WAR, the man behind the machine is just as important as the man behind the gun. Back of the production lines of every war industry is our first line of defense — the toolroom. Here, where precision is of utmost importance — where tolerances are reckoned in split-thousandths — you will find South Bend Lathes.

Modern in design, built with extreme precision, South Bend Lathes are fast and accurate on the most exacting classes of toolroom work. Their wide range of spindle speeds permits machining with maximum cutting tool efficiency. Their versatility facilitates quick change-over through a minimum of set-up time.

South Bend Lathes are made in five sizes: 9″, 10″, 13″, 14½″, and 16″ swing, with toolroom or manufacturing equipment. Write for catalog and the name of the dealer nearest you.

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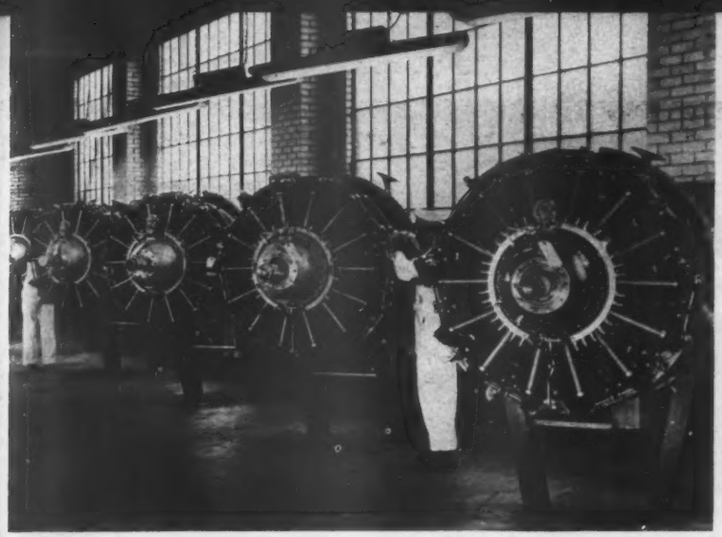
DEPT. 179, SOUTH BEND, INDIANA, U. S. A.

LATHE BUILDERS FOR 35 YEARS



Maintenance

Engines are disassembled after 725 hrs., washed, inspected, reassembled with replacements where necessary, and finally given test runs. The total operation takes five days.

Wartime Maintenance at United

Keeping the airliners flying is one of the most essential tasks of the war. The speed of overhaul is vital, but quality is more so, and both are achieved to a remarkable degree at United Air Lines, Cheyenne base.

By WILLIAM P. HOARE

Supt. of Overhaul and Repair Base, United Air Lines

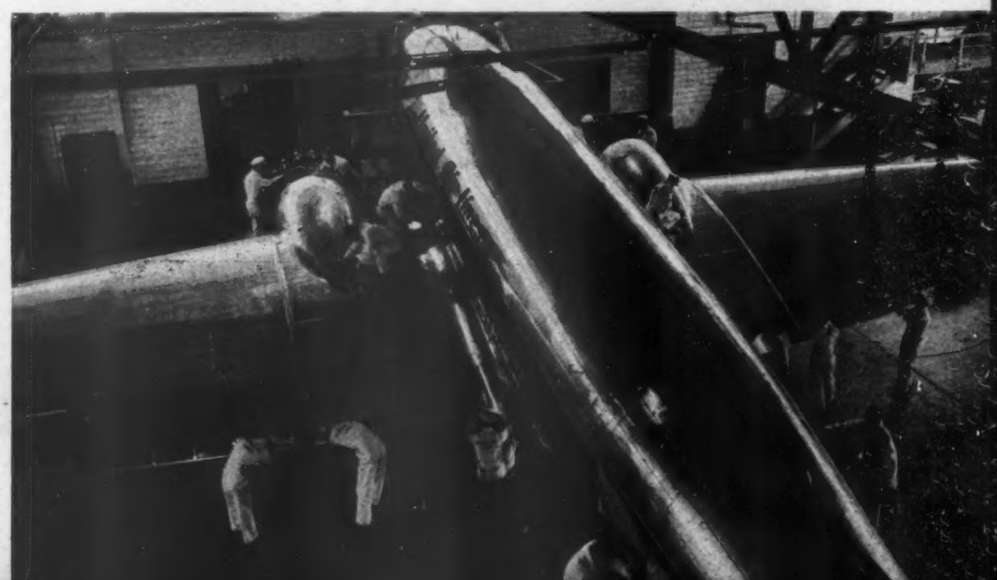
THE VASTLY INCREASED demands on transport plane equipment as a result of the war effort have stepped up the pace at major overhaul bases such as that of the United Air Lines at Cheyenne, Wyoming.

At this famous "roundhouse of the airways," 24-hr. shifts of maintenance experts are playing their unspectacular but vitally important part in keepnig air commerce moving on schedule, dependably and efficiently. War conditions have only tended to increase the painstaking care with which each Douglas DC-3 *Mainliner* is groomed at its prescribed overhaul periods, and the most modern facilities are being employed to insure the best results.

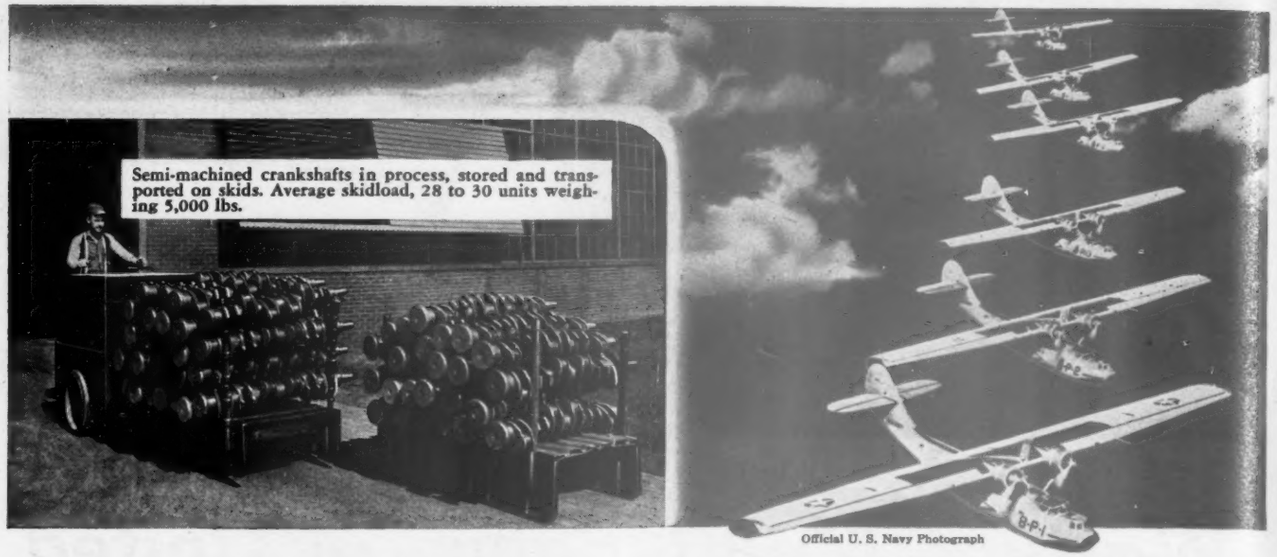
Established 14 years ago when commercial air transportation was young, the Cheyenne base steadily has grown and developed to meet the increasing needs and demands of airline progress. And a considerable part of the equipment used, as well as the methods employed, can be credited to the experience gained by United's own skilled workers down through the years. In this shop and that throughout the 96,300 sq. ft. of the base are numerous devices which have been developed and built by the company and which have benefitted the entire industry. Wartime requirements, along with company encouragement, are tending to stimulate employee initiative in the direction of improvements of both methods and facilities.

United's Cheyenne base supplements major servicing stations at New York, Chicago, San Francisco, Los Angeles and Portland. There are twelve shops at the central Cheyenne base—shops which almost constitute an aircraft factory. The 33 supervisors of these departments have had an average of 15 years of experience. Their watchword and that of the men under them is "thoroughness, first and foremost."

United's *Mainliners* go through periodic checks at service stations along the company's system such as a so-called No. 1 check, consisting of a visual inspection and engine run-up at every stop; a No. 2 check after every 25 hr. of flight, consisting of a thorough inspection of plane engines and propellers and of any necessary adjustments, and a No. 3 check after every 100 hr. of flying at which time tires are removed,



The 725-hr. check in which propellers, engines, instruments and landing gear are removed. This virtually complete overhaul is accomplished in 48 hrs.

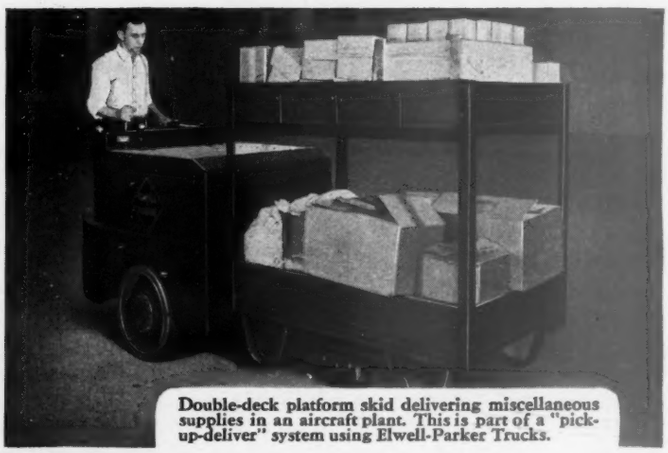


Semi-machined crankshafts in process, stored and transported on skids. Average skidload, 28 to 30 units weighing 5,000 lbs.

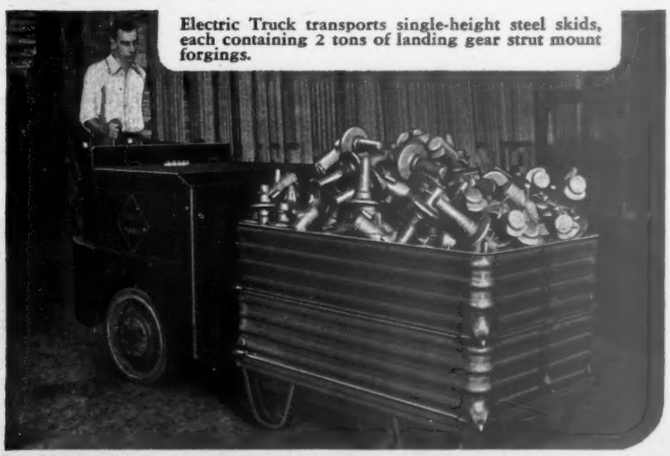
Official U. S. Navy Photograph

MULTIPLIED MANPOWER

GETS *MORE* PLANES UP *FASTER!*



Double-deck platform skid delivering miscellaneous supplies in an aircraft plant. This is part of a "pick-up-deliver" system using Elwell-Parker Trucks.



Electric Truck transports single-height steel skids, each containing 2 tons of landing gear strut mount forgings.

These pictures tell you what Elwell-Parker means by "Multiplying Manpower".

They show how you can bring this vital principle straight into your own plant—whether transporting big loads of airplane parts in order to help "get *more* planes up *faster*" or in other industries, whatever materiel you are producing.

1—To multiply *your* Manpower, put your main loads of supplies or unfinished parts into big-capacity skids as soon as they reach your plant.

2—Then pick up and transport the loaded skids on Elwell-Parker Power Industrial Trucks throughout each separate stage of machining, and to final assembly.

In less than 10 seconds, Elwell-Parkers set down or pick up loaded skid units—then travel swiftly but safely whether the pieces weigh tons or mere pounds. One operator and one Elwell-Parker power-driven Truck will outstrip *many* hand trucks because it has speed—which is the essence of Victory.

Right now, you need help in your other departments. Fill some of those jobs with ex-manual load handlers—they're already familiar with your plant!

If you can qualify for new equipment, we will do our best to help you add at least one Unit to your present Elwell-Parker fleet, and more later on.

The Elwell-Parker Electric Company, 4125 St. Clair Avenue, Cleveland, Ohio.

ELWELL-PARKER *Power Industrial* TRUCKS

ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

landing gear is checked, spark plugs are changed, oil is changed, controls are inspected and adjusted and various other items are given attention.

After every 725 hr. of flight, the *Mainliners* are routed to the Cheyenne base for thorough overhaul. Propellers, engines, instruments, radio equipment and landing gear are removed, the pilot's compartment and cabin are stripped of all furnishings, and center floor boards are taken up for inspection of control cables.

After every 6,000 hr. of flying, a *Mainliner* comes to Cheyenne for a major overhaul in which virtually the entire plane is disassembled. On emerging from this major going-over, the ship is almost a "new" plane.

There is no lost motion when a *Mainliner* rolls up to the airplane overhaul hangar. Mechanics nose it into an airplane "dock"—a wooden work platform which fits around the forward part of the plane. The work of disassembly begins immediately. Propellers come off first, then the engines are removed almost before they have had time to cool. One by one, the various items start on their parade through the shops of the base. Meanwhile, major items which already have been overhauled, such as engines and propellers, have arrived for installation.

Complete overhaul and in many cases manufacture of radio and electrical equipment is done in this shop. The test panel shown here contains the most modern equipment, much of it developed in the UAL laboratories.

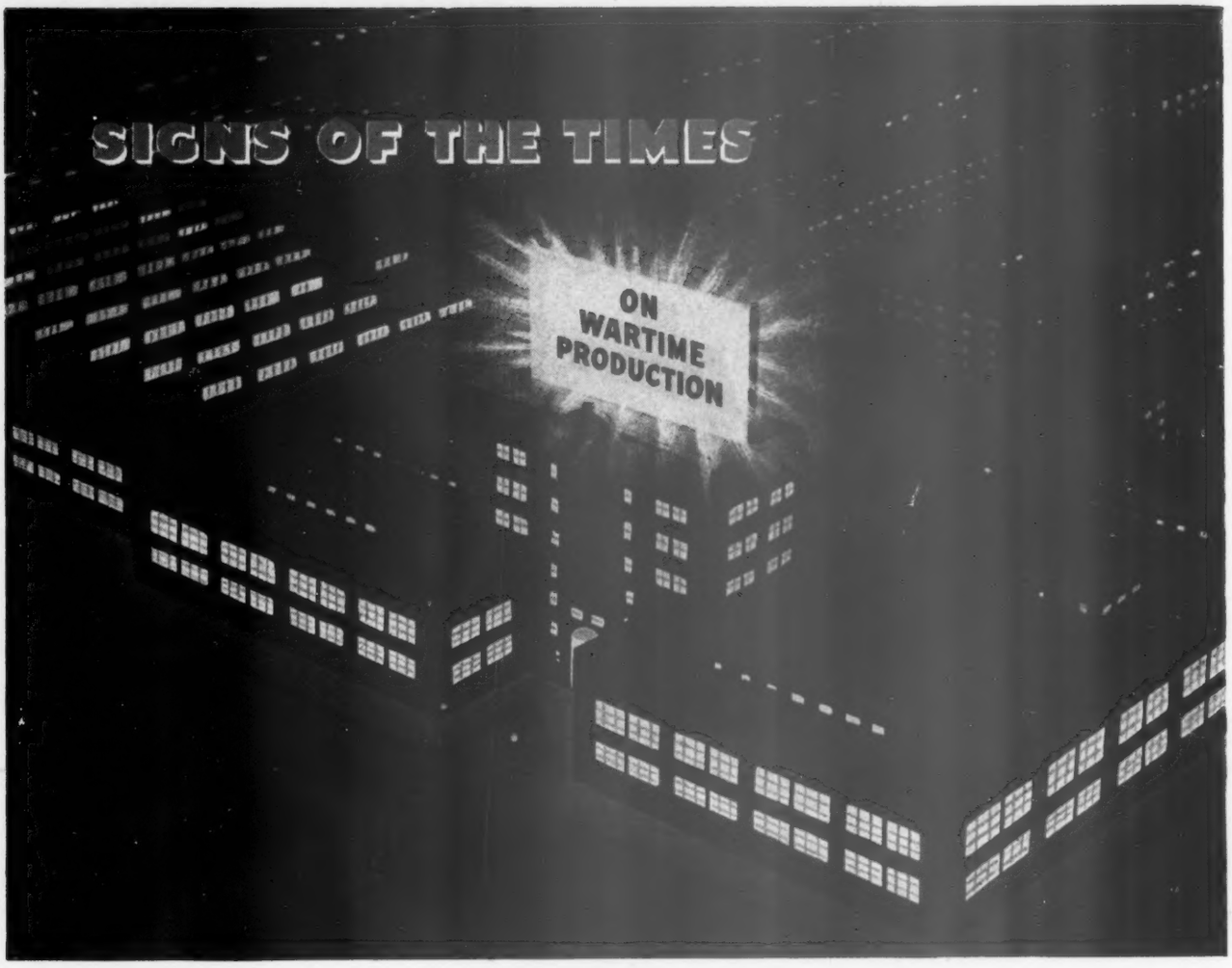
In the engine overhaul shop, all steel parts undergo continuous Magnaflux inspection.

In the propeller overhaul shop, propeller blades are ground and checked for balance. A feature here is a new propeller balancing stand and pit developed by United which is capable of taking propellers up to 14 ft. in diameter. Both paint and lead are used in obtaining correct balance.

Engines move to the engine overhaul shop where they are disassembled, washed, inspected, reassembled and given test runs in cells adjoining the shop. One modern facility of this shop is a continuous Magnaflux device where steel parts of the engines are magnetized and sprayed with a cast iron compound for a thorough check as to any flaws. Approximately five days are required for an engine to go through the engine overhaul shop. Careful tab is kept on virtually every part of an engine and parts are discarded after specified terms of service. As a result, an engine becomes virtually "new" after every five or six engine changes.

In the radio electric shop, skilled mechanics overhaul all radio and electrical equipment. A considerable amount of manufacturing also is done here. Facilities include numerous devices developed and built in United's own communications laboratory at Chicago. A series of test panels includes an automatic direction finder test panel, receiver test panel, interphone test panel, loop test panel. oscilloscope for visual checking of all equipment, audio signal generator for oral check of all equipment, vacuum tube voltmeter, communications unit test panel, audio power amplifier, loop gear box test panel, all-wave receiver for checking frequencies, microphone and headset test panel, autosyn test panel, relay and solenoid test panel, and dual generator test panel. All these devices contribute to the speedy and accurate checking of radio equipment by the most scientific methods.

In the instrument shop, watchmakers



New Production Requires New Paper Work Routines

Throughout America, shops and factories are engaged in new kinds of production. In the white heat of urgency they have had to forge new methods to insure greatest output in *limited time.* The application of methods engineering to new *time* and *cost* problems emphasizes the coequal importance of *paper work routines* that help to control production procedures. Simplification of paper work, plus accuracy and speed, are fundamental in Addressograph-Multigraph methods. *Simplification* to reduce the burden of detail and promote the smooth flow of instructions, information and records. *Accuracy* to avoid waste of time, money and materials and provide reliable costing. *Speed* to get more work done and increase productive capacity.

USERS OF OUR PRODUCTS are entitled to the services of our Methods Department. It can help to extend the use of their equipment in Purchasing, Storeskeeping, Production, Marketing, Shipping, Billing, Collecting, Disbursing and all key operations of business. To those who are interested in up-to-date information on better methods it is available on request, without charge.

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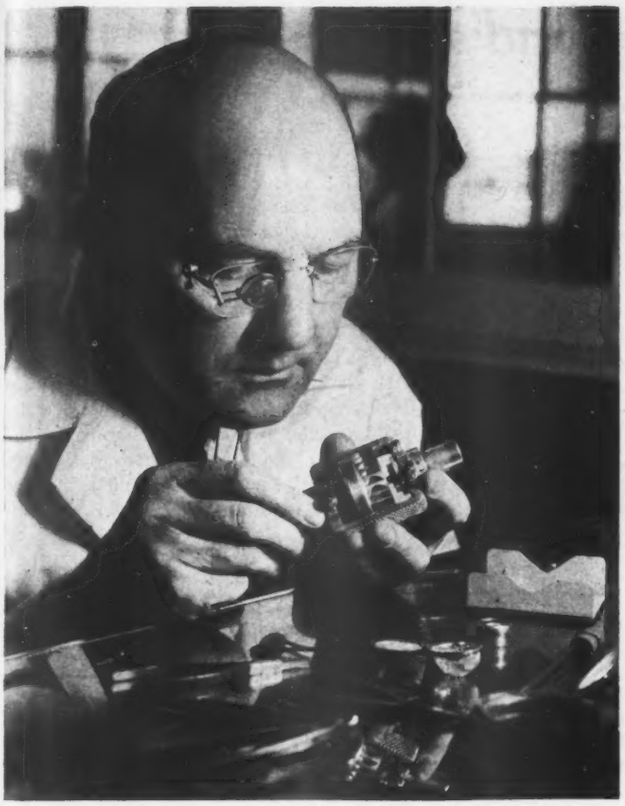


Approximately 500 instruments go through the instrument shop each week. Here a skilled technician is balancing and adjusting the rotor of an automatic pilot.

For such exacting jobs as reworking crankshafts this latest precision lathe has 27 speeds ranging from 15 to 1,000 rpm. and feeds ranging from .002 to .118.

and other skilled technicians check gyroscopic, mechanical, pressure and electrical instruments. There are 58 instruments in a Douglas *Mainliner* and approximately 500 go through the shop each week. To protect against dust particles, air is filtered on its way into the shop, then is turned over and filtered every three minutes.

Here there is a wide variety of test equipment including panels for checking tachometer indicators and magnetos, a Scorsby device for testing units of the automatic pilot, including directional gyro units, bank and climb units, balanced oil valves and servo units; a pressure chamber in which sensitive altimeters are calibrated and checked against readings of a mercurial barometer; an electrical instrument test stand, and a refrigerator and oven for hot and cold tests of various instruments.

In the accessory shop are seen still more of United's own developments for testing and checking. Among these are an engine accessory test panel used primarily in testing fuel, hydraulic, vacuum pump and other such accessories; a dual generator test stand, used for testing generators and control box units under loads imposed in regular service; a spark plug core tester for determining whether there is any electrical leakage around the mica of the plug, and another spark plug tester device used in observing the firing of spark plugs. These are only a few of the devices which are ranged around the large shop and which make possible precise, scientific checking of every item coming to the shop's attention from spark plugs to carburetors and from magnetos to de-icer equipment.

Some indication of the thoroughness of work in the accessory shop may be given by citing the handling of spark plugs alone. Each plug goes through 50 operations—and up to 10,000 plugs pass through the shop each month. Each spark plug is unwrapped and stamped with the date, plane and engine number prior to going in service. It then is checked on measuring gauges and disassembled. The core is buffed, cleaned, polished and baked for 16 hr. at 400 deg. F. to eliminate any moisture from the mica. It then is core tested and the plug shell is cleaned. Cores and shells are matched and assembled. The plug then is rebaked for six hours at 400 deg. It is checked for lightness and the electrode clearance is adjusted. It then is bomb tested before being packed, labeled and shipped to a station on the line.

A cabin repair shop goes over all cabin furnishings and manufactures new items for use not only on United planes but at company stations along the system. Seats, rugs, curtains and hassocks are just some of the articles produced by nimble-fingered men and women workers in this department.

In a large machine shop, workers produce new parts for planes and engines, make revisions of other parts, and service the landing gear of *Mainliners*. Operations include grinding and cutting, milling and shaping. Machines are of the latest types, including lathes, drills, shapers, grinders and drill presses.

There is an extensive sheet metal shop where a considerable amount of manufacturing is done in addition to routine servicing. Facilities include the usual sheet metal working tools plus a drop hammer, arc welding, gas welding and brazing equipment, a plating and etching shop, sandblasting equipment and a paint shop. Most of the servicing done in this shop concerns wings, ailerons and tail surfaces. Items manufactured range from small fittings to boilers, fairing and cowling.

Other departments include the battery shop, inspection department, and stock department. Then there is a flight test section which takes the *Mainliners* up for their check-out flights before they are given final adjustments and

(*Turn to page* 299)

The Technical Training Command's Maintenance Program

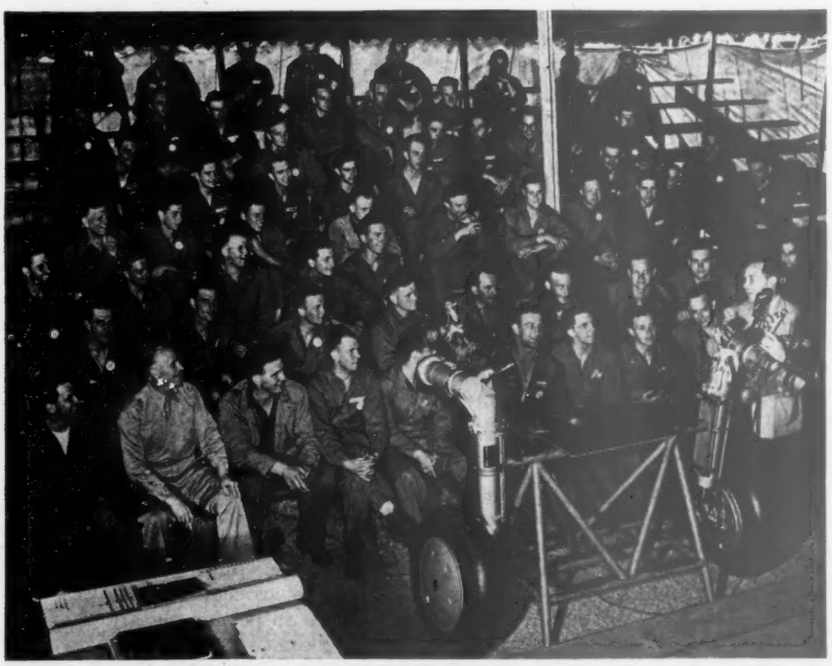
THE TECHNICAL Training Command of the Army Air Forces has the all-important job of providing mechanics and other highly skilled technicians to keep America's fighting craft in the air. To provide maximum training in the minimum of time for these much needed men, the Command has, in less than a year, expanded from a handful of army bases to a vast network of more than 50 stations and schools, under the leadership of Maj.-Gen. Walter R. Weaver.

In addition to the army's own training bases, private civilian mechanic schools have been incorporated into the training command as auxiliary training units. Almost every large city in the nation has one or more of these training centers.

Recently 20 leading aircraft manufacturers producing combat planes and engines for the Air Forces have organized post-graduate classes in their factories. Graduates of the advanced mechanics' courses will now have an opportunity to study the latest technical developments under the guidance of the aviation industry's engineers.

Although the Technical Training Command has had a mushroom growth, it is being directed by men who have had wide experience with flying from earliest army aviation. In 1938 the Command had but one base, Chanute Field, offering but three main courses: mechanics, communications and armament, plus a few specialist classes. In the following year there was a small growth, but still comparatively little attention was being devoted to the men behind the pilots who fly the planes. The air war in Europe soon brought the realization that planes must be sustained by adequate ground crews. The Command grew to its present proportions from there.

From the three original subjects, the curriculum has been expanded to 22 highly technical courses. Today it is possible for almost any interested man to become a skilled mechanic or technician, to learn a trade that he will be able to ply after the Victory. He may become a trained and experienced radio operator and mechanic, airplane mechanic, aircraft machinist, metal worker, welder. Link trainer instructor, parachute rigger, teletype operator, powerplant, instrument or propeller expert, electrician, weather forecaster, aircraft armorer, photographer, bomb-sight or power turret, mechanic.



Army student mechanics of the Technical Training Command listen to a lecture on the servicing of hydraulic landing gear at Douglas Aircraft. Maj. Wm. L. F. Pooley, the Army's district supervisor for the training program is seated in the front row.

In the schools conducted in the airplane factories, the advanced mechanic becomes familiar with the new types of combat planes, engines, propellers, gun-turrets, and other units being manufactured. They come in actual contact, along the production and assembly line, with the flying equipment that will be their responsibility under combat conditions. The advanced mechanics, upon graduation from the factory school courses will serve as key men in the plant and maintenance crews.

Trainees from Army

These army airplane mechanics and technicians are drawn from new army personnel, making above average on the general classification test. A large percentage of the men assigned to the Technical Training Command are from the group of soldiers that have made 100 or better on this first and important examination given soldiers upon induction into the army. If an inductee wishes to eventually become an airplane mechanic, he should redouble his efforts on the classification test and his chances of realizing his hopes are increased many fold.

Once the new soldier has made the required mark of 100 and has been assigned to the Command, he is sent to one of the four replacement centers. There soldiers receive four weeks of basic military training and an aptitude test to determine the technical course for which they are best suited. Once this has been ascertained through cleverly devised examinations, the men are immediately sent to the Air Force technical schools.

Soon the students are working on planes and accessories at any one of the numerous schools and from this basic training, thousands of men go to the advance courses or post-graduate work in the aircraft factories.

The basic course of 18 weeks of instruction would cost a civilian more than $1,000 if he attended a commercial school. For example, a civilian studying to be a weather observer and forecaster, can only take such a course in a college at a cost of several thousand dollars, according to the training experts, but an enlisted man can get the same course without charge or the usually steep preliminary requirements. Soldiers assigned to this command can, therefore, not only aid in the country's war effort, but can apply for specialized work after the war is over.

2 MONDAY MORNING.
Fire Guts Plant
OUT OF PRODUCTION—
for 24 hours!
BURBANK, MAY 18, 1942: Fire of undetermined origin destroyed much of the plant and equipment of Aero Tool Company, 231 W. Olive Ave., at noon yesterday. Four engine companies answered the alarm as the blaze roared furiously, consuming a part of the structure within an hour.
While to witnesses it appeared that the plant and equipment, which was engaged in the manufacture of aviation tools, was out of production, a telephone call to Lester Deutsch, the president, brought assurance that every effort would be made to resume operations
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FIRE WHICH YESTERDAY DESTROYED OUR PLANT WILL AFFECT NEITHER THE QUALITY NOR THE DELIVERY DATES OF CUPFORGED TOOLS. OUR APPRECIATION GOES TO FRIENDS IN THE INDUSTRY WHO, RECOGNIZING THE IMPORTANCE OF AERO TOOL PRODUCTS IN THIS WAR, HAVE TEMPORARILY MADE THEIR EQUIPMENT AVAILABLE TO OUR CRAFTSMEN. PRODUCTION UNDER AERO TOOL SUPERVISION WAS RESUMED WITHIN 24 HOURS. NEW EQUIPMENT IS ON ORDER=
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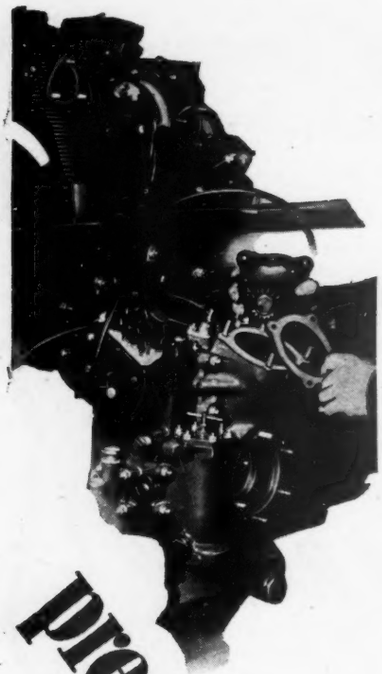

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Stock shim materials obtainable from mill supply dealers. (Write us for shim application folder and Laminum sample.)

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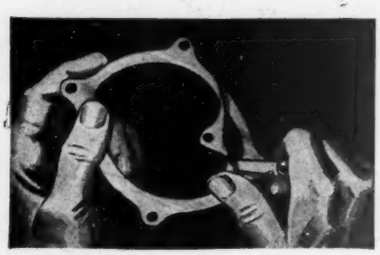

it's
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THE SOLID SHIM THAT peels FOR ADJUSTMENT

1813

Upon completion of his training, the mechanic is assigned to an operating air base where he must spend several months under the supervision of non-commissioned experts, and it is here that he learns to function as a member of a ground crew.

Some of the qualified graduates are assigned as flying members of the airplane crew, among these being radio experts, aerial photographers, gunners, flight engineers, and so on.

The task of training the thousands of mechanics and technicians needed for plant and maintenance crews is tremendous. It is a training problem that will increase in direct ratio to the plane production and pilot training programs of the Army Air Forces. To accomplish this goal of properly preparing more than one-quarter of a million mechanics yearly, every available source of training in the nation is being recruited and expanded to insure continuous source of experts. Every plant that can train soldiers in the repair and maintenance of planes and accessories is being coupled with the great training centers that form the nucleus of the Technical Training Command.

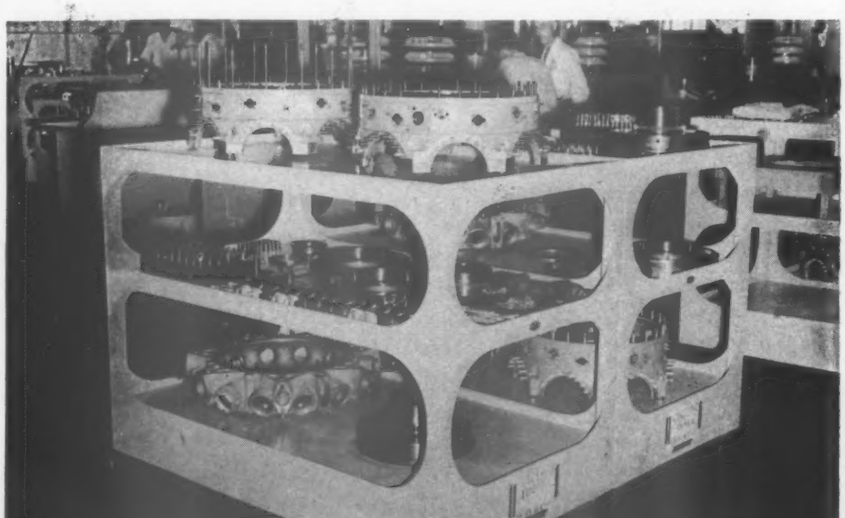
Engine Pre-oiler Unit

A new engine pre-oiling device, used to prevent wear when an engine is started cold, has been developed by students at the Boeing School of Aeronautics, division of United Air Lines at Oakland, Calif.

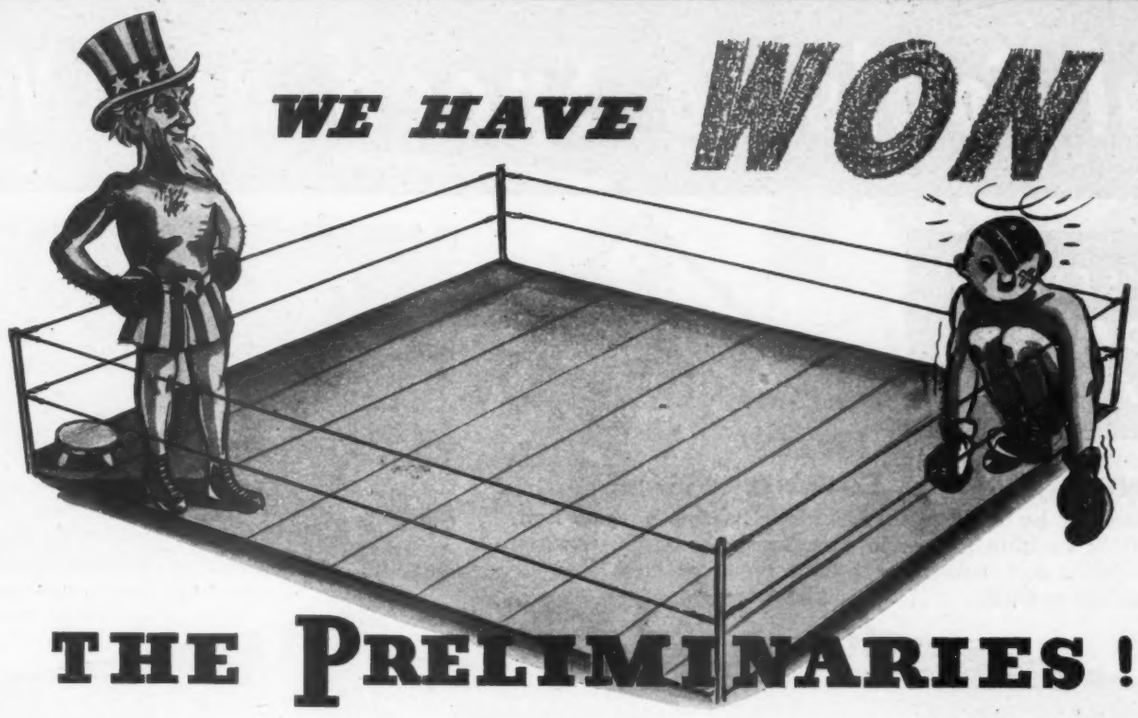
The device consists of a two-gallon tank, storage battery, electrically operated gear pump and pressure relief valve, all mounted on wheels for convenience in handling.

The lubricant circulated by the pre-oiler may be the same grade as that contained in the engine, or a light grade may be used. If the same grade, the oil should be heated and then circulated through the engine under pressure. Whether the oil is heated or a light grade is used, pre-oiling insures a quicker start and eliminates wear.

Pre-oiler unit to prevent bearing wear when engine is started cold.



A parts stand made of wood instead of steel by Pan American Airways for its engine overhaul shop. The new-type stands, built to conserve war metals, have been found as practical as those of metal and are lighter in weight.



THE PRELIMINARIES !

● Yes, Uncle Sam has won all the preliminaries to the main bout.

We have won the design, engineering and production battles. With the preliminaries out of the way, we will soon hear the gong for the main bout.

Although it requires the application of all the effort and intelligence we can put forth, at the Romec Pump Company, we will continue to do our part in producing more and better aircraft pumps.

As the crew cannot perform better than their hearts so the planes and motors cannot perform better than their pumps.

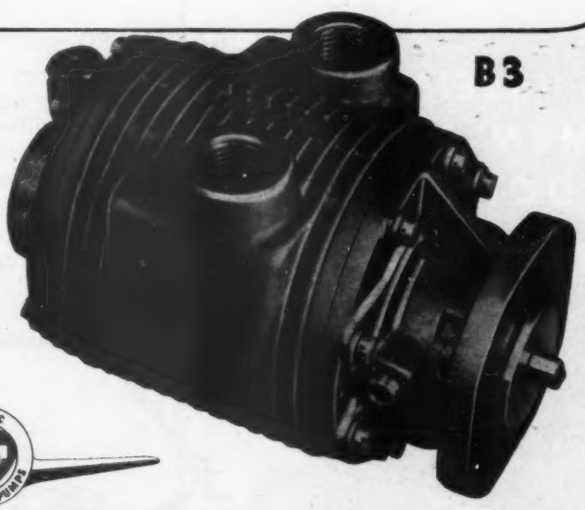
* * *

Inquiries on engineering details are invited from engineers and executives in war production plants.

B-3B

Illustrated: ROMEC medium capacity Vacuum Instrument and De-icer Pump, B-3B and B-3.

B3



ROMEC PUMP COMPANY

Elyria ★ Ohio ★ U. S. A.

Manufacturers of ENGINE-DRIVEN PUMPS, ELECTRIC MOTOR-DRIVEN PUMPS, and HAND OPERATED FUEL PUMPS

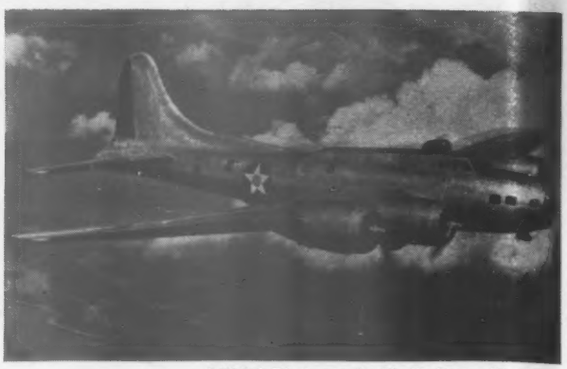
On the Production Front and

Vital Tools to Speed and Win O

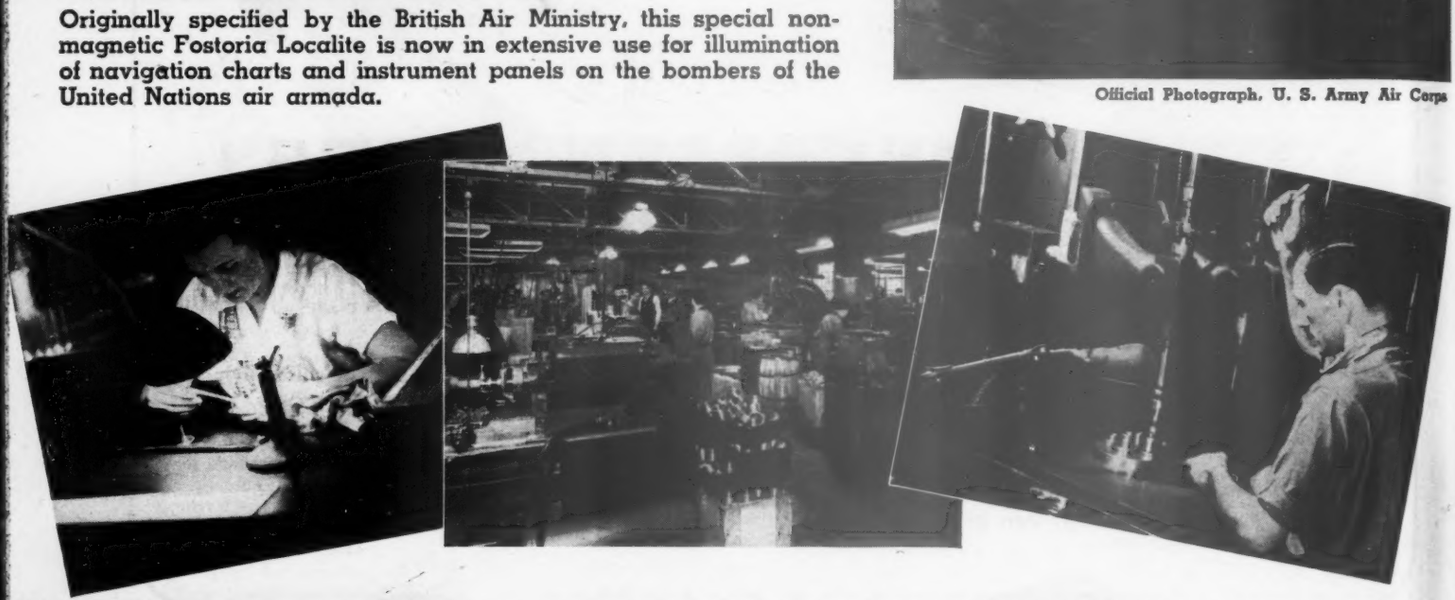
VITAL "SEEING" FOR BOMBER NAVIGATORS

NON-MAGNETIC FOSTORIA LOCALITE

Originally specified by the British Air Ministry, this special non-magnetic Fostoria Localite is now in extensive use for illumination of navigation charts and instrument panels on the bombers of the United Nations air armada.



Official Photograph, U. S. Army Air Corps



VITAL "SEEING" FOR MEN AT PRODUCTION

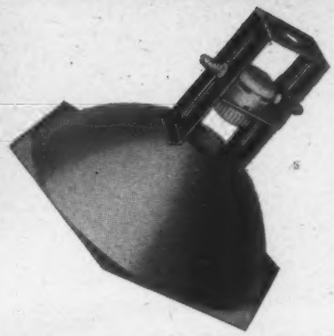
"BALANCED LIGHTING" FOR BETTER "SEEING" ON THE JOB

Of all the tools required for the success of today's War Production Programs none is more vital than the workmen's eyes. Seeing ability depends on good light—not only general illumination — but of equal importance, "close-up" illumination of high intensity right on the job where clear, unstrained "seeing" is the first requirement for speedy, accurate workmanship.

Fostoria provides both in proper combination — Balanced Lighting. Like in hundreds of plants now converted to war production, the aviation industry is making increasing use of this potent production weapon.

...nd the Fighting Front ...in Our Air Offense

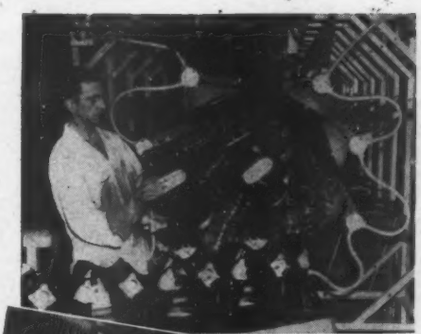
VITAL SPEED FOR BAKING AND DRYING



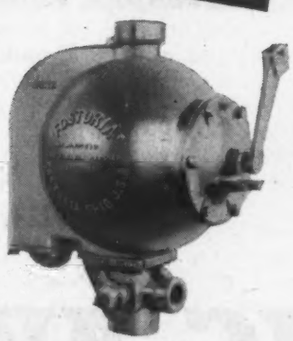
FOSTORIA NEAR INFRA-RED PROCESS EQUIPMENT

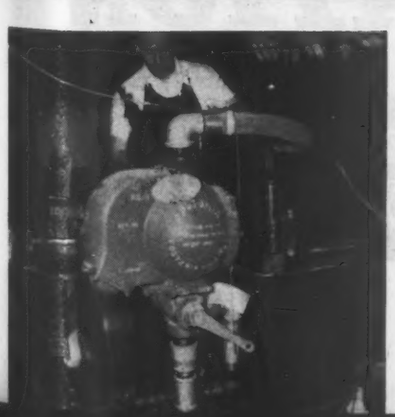
A relatively new production tool, the modern Near Infra-Red Process is now enabling war plants to obtain amazing increases in baking and drying operations.

Ideally adapted to line production methods, Infra-Red cuts time from hours to minutes, saves space, provides visible operation, eliminates "stand-by" loss, and reduces costs. Equipment as engineered by Fostoria is quickly available on proper priority.



VITAL SPEED AND PRECISION FOR GRINDING





FOSTORIA LOCALIZED COOLANT FILTER

Speedier grinding, finer finishes, fewer wheel dressings, are the enthusiastic praise of leading aircraft manufacturers and hundreds of war plants now equipped with Fostoria Coolant Filters. Designed for individual grinder application, this Fostoria production tool assures a sludge-free coolant and a superior cutting job by each grinding wheel.

INDUSTRIAL **fostoria** SERVICE

For Counsel On Lighting, Drying and Grinding Problems

CALL OR WIRE YOUR NEAREST FOSTORIA INDUSTRIAL SERVICE STATION

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The John A. Dodd Company
299 Techwood Dr., N.W. Phone: Jackson 1695

BALA-CYNWYD, PA.
The J. V. Calhoun Company
349 Montgomery Ave.
Phone: Greenwood 4477 at Phila.

BIRMINGHAM, ALA.
National Distributors, Inc.
1925 Fifth Ave., N. . . . Phone: 3-6259, 3-6250

BOSTON, MASS.
Fostoria Engineering Service
(Div. of Copley Sales Co.)
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Sprague Electrical Supplies, Inc.
777 Main Street . . . . . Phone: 4-2141

BUFFALO, N. Y.
Fostoria Industrial Service
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404 N. Oak St. . . . . Phone: Lafayette 8135

CHARLESTON, W. VA.
Charleston Electrical Supply Company
Phone: 26-157

CHARLOTTE, N. C.
Mill Power Supply Company
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CHATTANOOGA, TENN.
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Fostoria Industrial Service of N. Y.
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THE FOSTORIA PRESSED STEEL CORP., Fostoria, Ohio

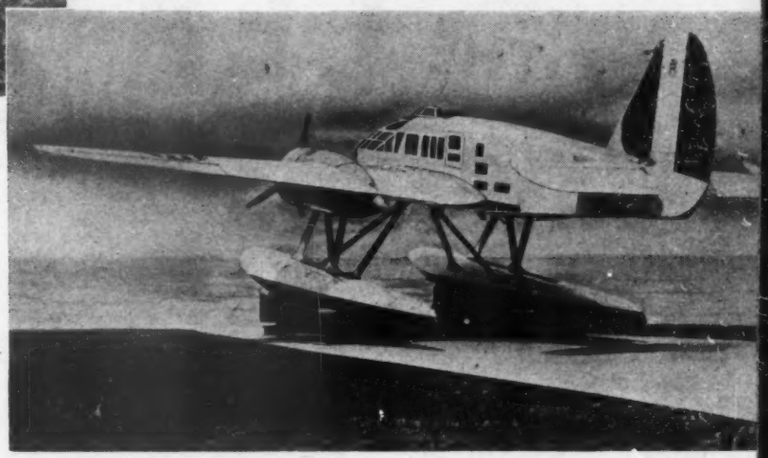
Fostoria Products Manufactured and Distributed in Canada by Amalgamated Electric Corp., Ltd., Toronto, Canada.

NOCTURNAL PROWL . . . the somber silhouette of a mighty Republic *P-47* THUNDERBOLT in the stratosphere portends sudden disaster for Axis planes caught out in the night air. Republic Aviation Corp., Farmingdale, Long Island, New York.

REPUBLIC AVIATION

REPUBLIC AVIATION

The Heinkle He. 115K2 is a very capable torpedo-dropping airplane which can take off from convenient harbors and bays to prey on Allied shipping on the routes to Russian Baltic ports.



The Italian Caproni 312 is another water-based torpedo plane which might be requisitioned by the Nazis to strike at Allied shipping from short range vantage points. The craft is faster than most of its type, but has very short range and would be practically defenseless if caught.

Hitler's Latest Weapon

Hitler has many cards up his sleeve, and the time seems to be ripe for the pulling of another—the water-based torpedo plane. Like the other weapons, it will be beaten, but it may have some momentary possibilities.

By FRED LAMOREUX

THERE ARE A NUMBER of indications that Germany will use torpedo carrying planes on a large scale this summer for attacks on Allied shipping.

Two recent news dispatches seem of special significance. The first is the British Admiralty report of May 7 on the recent German attack on British convoys, bound for Russian Arctic parts. It reads in part as follows:

"This convoy was subjected to air attack on the evening of May 2. This time the attack was by six torpedo carrying aircraft. At least one enemy aircraft was destroyed but three ships of the convoy were hit by torpedoes and sank."

Perhaps the heaviest British bombing attacks of the war have been the three raids on Rostock and its environs and on the Heinkel airplane factories there. In the May 2, *British United Press* report there is this passage:

"Two buildings in the yard where between two and four Heinkel 115 torpedo or bomb carrying seaplanes were completed weekly were also damaged."

We see in the one dispatch how effective the torpedo carrying plane is and we see in the other dispatch the determined British effort to stop the construction of them.

A torpedo plane is a far more efficient weapon than a submarine, except in one particular. The plane can be built in quantity at a fraction of the cost of a submarine. It requires a crew of two or three who are comparatively easy to train. It finds its victims much more quickly and easily and goes back for another torpedo in a matter of hours. It does not have the cruising range of the submarine nor the ability to stay out in all weather for weeks on end.

It is interesting to compare the effectiveness of the different weapons, submarines, destroyers, dive bombers and torpedo planes, all four of which were used in the attack just mentioned on the British convoys. Three destroyers and one or more submarines got the cruiser *Edinburgh* and one cargo ship, with a loss of one destroyer and serious damage to another. Six dive bombers made two attacks on the convoys, lost two planes and did no damage. Six torpedo planes made one attack, lost one plane and sank three cargo ships. Compare the German loss in each case with the return they received for it. It is only fair to say that dive bombers have done better in other cases.

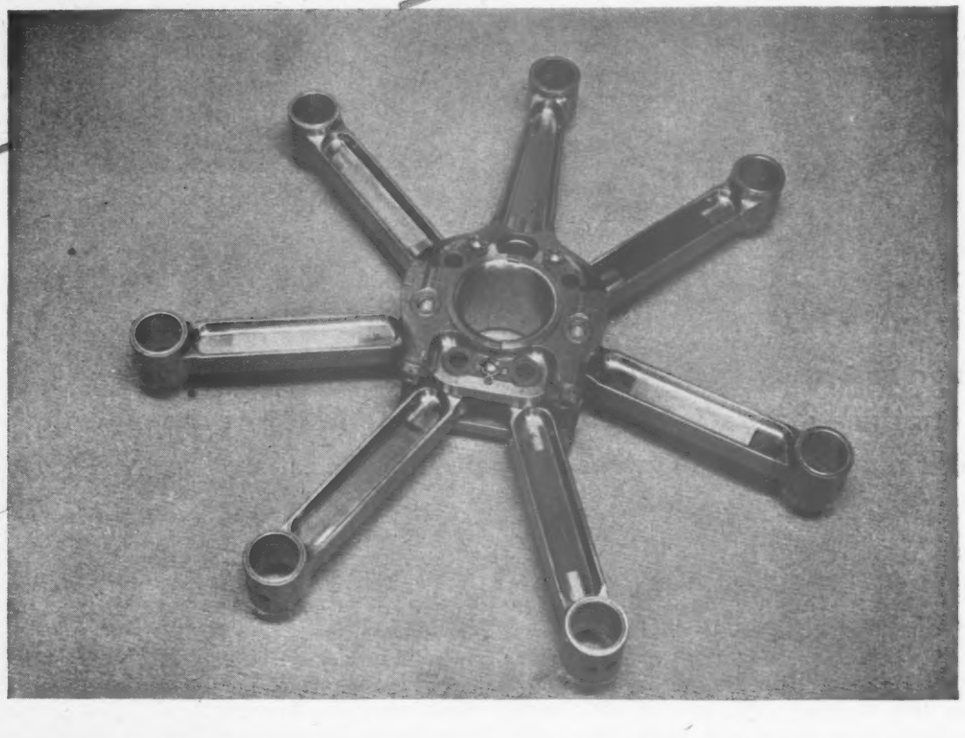
The torpedo plane has also been very successful against warships. With it the British disabled the battleship *Bismarck* and wrecked part of the Italian fleet at Taranto and with it the Japanese sank the *Repulse* and *Prince of Wales*.

(*Turn to page 299*)

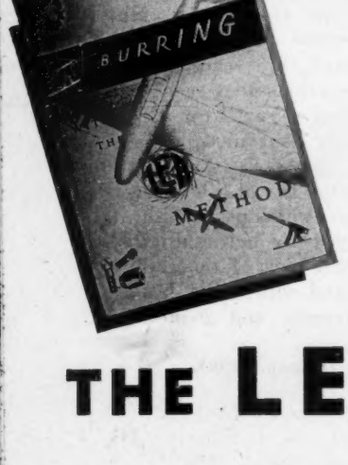
FASTER PRODUCTION

CLOSER TOLERANCES

BY THE LEA METHOD OF POLISHING and BURRING



Connecting rods, such as illustrated, are typical of the many engine and plane parts on which the Lea Method of Polishing and Burring is being successfully used.



HARD wheels, hand filing, emery cloth, burring tools . . . for many operations these are now obsolete, time-consuming, labor-wasting operations—and often not too precise as to results.

By contrast, the LEA Method of Polishing and Burring, already adopted by many plane, engine and parts manufacturers, is much faster and permits adoption of much closer tolerances.

The LEA Method makes use of specially-designed bobs or wheels and selected grades of Lea Compound, a greaseless composition with special cutting and polishing properties.

Can we be of help? In writing for further details, please give as much information as you can about the polishing or burring of part or parts under consideration. Send samples, if you can.

7-LM-1

THE LEA MANUFACTURING CO.

Waterbury, Conn.

Specialists in the Production of Clean-Working Buffing and Polishing Compounds

Photo by Southeast Army Air Forces Training Center

LEARNING AIR TRAFFIC CONTROL

Student control tower operators at Maxwell Field, Ala., direct traffic of incoming "bombers" in special school for airport traffic control operation. Pvt. F. F. Terry, left, directs landing of incoming "plane" while Pvt. J. V. Nelson, right, communicates with approaching bomber. Vast increase in air traffic necessitated training of traffic control personnel, resulting in this special course designed by Technical Sergeant J. W. Perry on pattern of CAA control system for civilian transport operations.

Air Forces Continue Expansion

The War Department has authorized construction of Air Force Training Schools at Seymour, Ind., Laurinburg-Maxton, N. C., Altus, Okla., Bainbridge, Ga., Boca Raton, Fla., Childress, Tex., Sedalia, Mo., Newport, Ark., Greenwood, Miss., and San Marcos, Tex., most of which will cost more than $3,000,000.

In addition, the department has authorized an Air Force installation for Yakima, Wash., and has begun construction of flight strips along highways.

Army Develops Traffic Control Course

Sergeants, corporals—even buck privates—are being taught by the Army to tell officers what to do and when to do it.

Heavy increase in air traffic has made imperative the training of personnel to handle landings and take-offs of all types of aircraft at the Southeast Army Air Forces Training Center at Maxwell Field, Ala., where enlisted men are being given a three-week practical course in the main functions of the Army Airways Communications system.

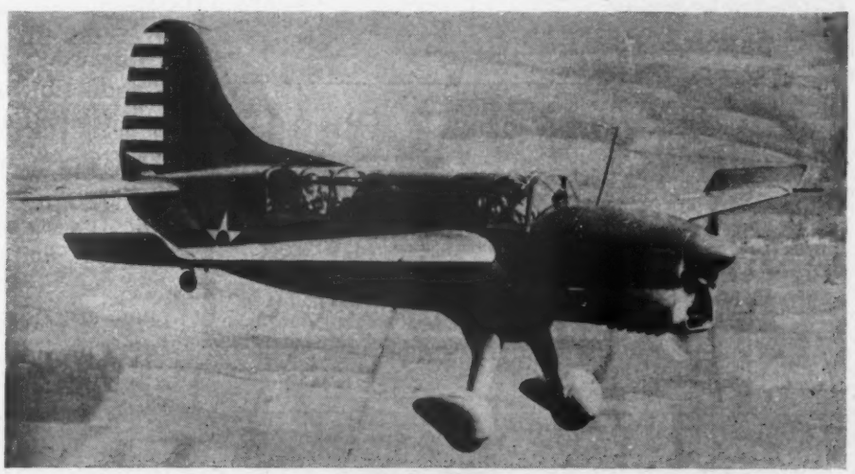
The course, devised by Technical Sergeant Joseph W. Perry and taught by Staff Sergeant Glen Mackey, is patterned after that developed by the CAA for scheduled airline traffic control and students are all graduates of the Air Corps Communications Schools. Many of them have had radio or traffic control experience in civilian life.

The course is given on a miniature airport complete with runways, hangars, obstructions, model aircraft and two-way radio communication between instructor and student operators who take turns "flying" the model planes around the room complying with orders issued in the "control tower."

Glider Schools Established by Army

Large scale glider pilot training for military service has been inaugurated for the Army Air Forces, the War Department has announced. Pre-glider training contracts have been signed with 19 CPTP schools in the midwest, who will give candidates training in light airplanes, emphasizing dead stick landings. Candidates will then be sent to Army glider schools for training first in small, then larger, gliders.

Those eligible for such training include men 18 to 35 who have had civilian pilot training but who have been ineligible for aviation cadet training. Applicants must meet physical requirements set for aviation cadet applicants with a rating of Class 2 or better; vision must be at least 20/40, correctible to 20/20. They must not have been eliminated for flying deficiency from primary pilot training in the Army, Navy or CAA and must have graduated from CPTP elementary course or hold CAA Private Airman certificate or higher, or submit evidence of participation in a minimum of 200 glider flights.



"SEAGULL" TRIES ITS WINGS

Shown here is the new SO3C-1 "Seagull" scout observation which, according to a company announcement, has been in production for the Navy for some time at a midwestern plant of the Curtiss-Wright Corp. Powered with a Ranger inverted "V" engine the craft, on which performance and specification data have been restricted, is designed to serve with the battle fleet, operating either on wheels or floats. Of particular interest are the unusual wing tip construction and extremely large vertical stabilizer.

HOLD THAT PRO

OLD-FASHIONED WIRING HAS NO PLACE IN 1942 WAR PLANTS!

MASS PRODUCTION...BUILT FOR ROUND-THE-CLOCK OPERATION

This is a war of horsepower — on the *factory* front as on the *fighting* front. There is no place for frills, no excuse for waste, no room for horse-and-buggy methods.

Power, in wartime industry, has a clear-cut job —to keep machines running, every minute of every hour, every hour of every day.

It cannot ask for time out, while willing workers stand idle. It cannot falter under heavy loads. It must save every possible cent of operating and upkeep cost — every possible ounce of war-scarce materials.

Geared to the Pace of War Production

Industrial America has turned to the bus duct method of distributing light and power for the simple reason that it meets every one of these needs *as no other method does.*

The BullDog Electric Products Company pioneered bus duct systems 15 years ago, chiefly to meet the growing needs of the automobile industry. They are designed for mass production, by mass production experts.

BullDog believes it worth while to review the main advantages of these systems for executives whose job it is to *get war work done.* Here they are — briefed to the reading time of busy men:

Power and light *where* they are needed, *when* they are needed.

System can be installed in new plants without waiting for machine layout . . . and machines can go to work as soon as the roof is on.

Tool set-ups can be changed — machines shifted — with no interruption of light or power.

Power operates at higher efficiency, with less voltage loss, than in any other system.

An enclosed electrical system, protected against breakdowns, sabotage, accidental short circuits.

System is engineered for maximum efficient use of critical materials. Eliminates need for rubber and aluminum.

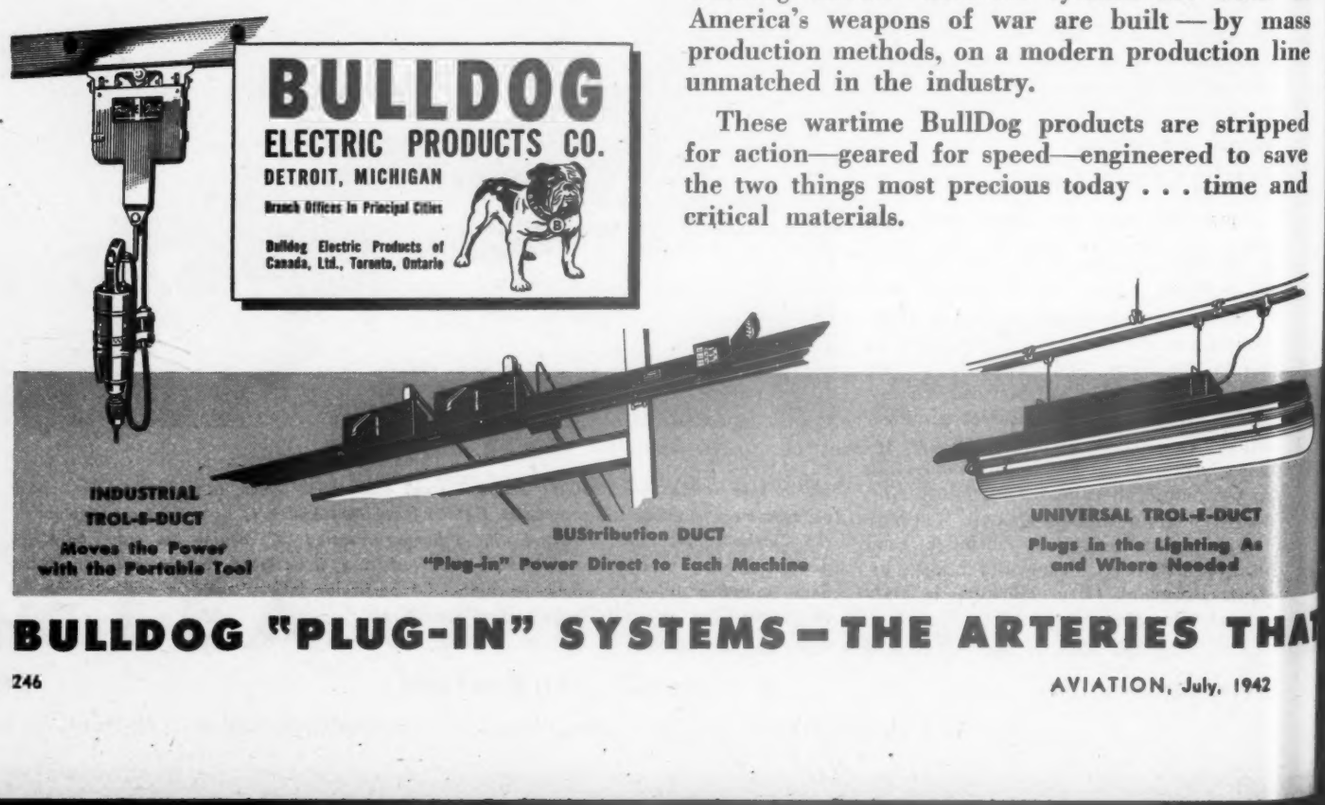
Installation in a fraction of the time required for old-fashioned wiring, with a big saving of engineering time for layout.

Standard, interchangeable sections — 100% salvable. Instantly convertible from one production set-up to another.

Mass-Produced . . . for Mass Production

BullDog flexible electrical systems are built as America's weapons of war are built — by mass production methods, on a modern production line unmatched in the industry.

These wartime BullDog products are stripped for action—geared for speed—engineered to save the two things most precious today . . . time and critical materials.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Bulldog Electric Products of Canada, Ltd., Toronto, Ontario
INDUSTRIAL TROL-E-DUCT
Moves the Power with the Portable Tool
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"Plug-in" Power Direct to Each Machine
UNIVERSAL TROL-E-DUCT
Plugs in the Lighting As and Where Needed

BULLDOG "PLUG-IN" SYSTEMS—THE ARTERIES THA

DUCTION LINE!

THIS JOB CALLS FOR ELECTRICAL SYSTEMS DESIGNED FOR ...ENGINEERED TO SAVE TIME AND CRITICAL MATERIALS

"When do we start producing?" was the question asked, as the huge new engine plant shown above neared completion.

And here was the answer: "As soon as the first machine is set up and ready to run! You can plug in one machine or a battery of them — and get going."

Hours, perhaps days, of precious production time were saved—because BullDog pre-fabricated electrical systems had followed the roofers right down the building. Power and light were ready the minute the roof was on.

Parallel runs of BUStribution DUCT *for power* and Universal Trol-E-Duct *for light* are accepted as the best there is today — an integral part of an up-to-date production system, and as modern as the machine tools they serve. No old-fashioned wiring system can do their work.

HUNDREDS OF LEADING U.S. ARMAMENT PRODUCERS ARE BULLDOG USERS

BullDog Bus Duct Systems have been used in re-wiring hundreds of established plants and equipping hundreds of new ones — among them the largest and most important producers of war materials.

Because of the speed with which they can be engineered and installed, BullDog Systems in many instances have made it possible to start production on vital military contracts weeks ahead of schedule.

They have also made plant conversion far easier, have simplified the moving of machines and lights, and in many other ways have contributed to the speed and efficiency of war production in every field.

SUPPLY POWER AND LIGHT FOR WAR PRODUCTION

An Outstanding Aviation School —Outstanding Graduate Success

5 career courses

1 Year **AERONAUTICAL ENGINEERING**—Intensive, practical training restricted to subjects directly related to aeronautical engineering. This is the shortest possible SUFFICIENT training for a sound start on an aeronautical engineering career.

2 Year **AERONAUTICAL ENGINEERING**—Includes advanced training, research, and aircraft development experience, leading to Bachelor of Science degree (through affiliation with West Coast University).

12 Month **AIRCRAFT MECHANICS**—Covers all phases of aircraft production and airplane and engine maintenance (airline) duties. Course approved by U.S. Civil Aeronautics Administration as preparation for obtaining mechanics' licenses.

6 Month **AIRPLANE CRAFTSMAN**—Thorough, practical training in modern aircraft construction and maintenance...permitting early employment, yet supplying a solid foundation for a career in either aircraft manufacturing or commercial aviation.

COMBINATION AIRPLANE CRAFTSMAN—Two months of specialized shop training at the school preceded by 6 to 12 months of study at home. Provides immediate practical skill, plus broad technical knowledge for steady advancement to more and more responsible duties.

Also PLASTICS Training

...in the design, engineering, molding and fabrication of plastics, with special attention to the important and growing use of plastics in aeronautical applications.

The superb training facilities and authoritative training methods of Aero Industries Technical Institute are recognized as outstanding, both by the Aviation industry and by the highest educational standards.

Here there are classrooms as well as shops. Here there are texts as well as tools. Here one studies, as well as practices, his chosen field of Aviation. Large aircraft construction, maintenance, and overhaul shops like those of major aircraft manufacturers and airlines make possible every phase of practical aircraft duties. Laboratory, research, experimental, and aircraft development facilities permit the most advanced and most specialized types of training. Here the students can—and do—carry out actual aircraft projects from drawing board to test flight as a standard feature of their training.

Over 4200 Graduates Employed by All Leading Aviation Firms in the Last 4½ Years

The advantages to the Aero Tech graduate of this broad and thorough training are constantly demonstrated in better starting positions, more rapid advancement, security, and greater success...as exemplified by the outstanding records of over 4200 Aero Tech trained mechanics and engineers now employed by all major airlines, all major aircraft manufacturers, and many other leading firms in all divisions of Aviation.

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Contractor to U.S. Army Air Corps

"Enlisted" for the Duration

Much of the extensive training facilities and personnel of Aero Industries Technical Institute is devoted to the training of Air Corps personnel for specialized maintenance duties. We are proud to render this vital service to the nation, while at the same time continuing civilian training of selected men who can step into important engineering, production, and maintenance duties. After the war Aero Tech's expanded facilities will be devoted solely to superior aeronautical training for America's youth.

By W.W. MACDONALD

Radio

Receiver for Light Ships

A new 4-tube "Ranger" receiver built by the Electronic Specialty Company of Los Angeles expressly for use in CPTP and Civil Air Patrol ships measures 5½ x4½x8 in. overall and weighs only 6 lb. 3 oz. complete with built-in dry batteries furnishing all necessary operating potential.

The receiver performs three functions, providing continuous turning between

Triple-function receiver. It provides continuous tuning from 195 to 410 kc., "spot" switching to 3,105 kc. and serves as a pilot-observer interphone. All batteries are built-in

195 and 410 kc., a 3,105 spot frequency for picking up messages from other ships to ground stations and a two-way interphone for communication between pilot and observer. The interphone arrangement is interesting in that jacks are provided on the receiver panel for two sets of headphones and two sets of microphones. Incoming radio signals are audible to both pilot and observer. Pressing of a button on either microphone suppresses incoming radio signals so that the inter-com feature may be used without interference.

A companion 5-tube, 3105 kc. transmitter, also available in the Ranger line, is the same size as the receiver, is similarly operated by internal dry batteries and weighs 7 lb., 5 oz.

Two New UAL Service Devices

United Air Lines has developed two new test devices for use in service shops along its lines, according to P. C. Sandretto, superintendent of the firm's communications laboratory.

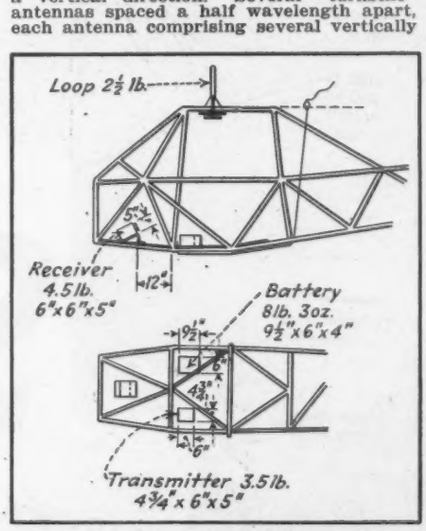
One device, designed by H. N. Wilcox, is a vibration generator which permits communications equipment to be checked under conditions more severe than those normally encountered in flight. Air-operated, the device is equipped with electrical control holding vibrations constant at 30-cycles per second. Amplitude of vibrations may be varied to simulate conditions up to 3 g's for a 100 lb. load. The test table upon which units to be checked are mounted may be varied through 360-deg. for convenient inspection of such units during and after a test.

E. A. Jensen has designed a signal generator for aligning and measuring the frequencies of all radio receivers carried aboard UAL Mainliners. It generates 24 crystal-controlled frequencies and can be adapted to handle up to 40. Output ranges from one microvolt to one volt. Modulation up to 100 percent is available at six different audio frequencies.

Significant Patents

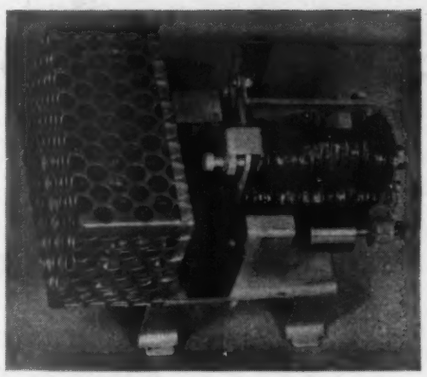
Patent papers are often obtusely worded and rarely "tell all" but a man with imagination can, by reading between the lines, plot the probable course of many "things to come." Hence the following brief notes concerning recent patent grants:

No. 2,272,060, to E. A. Laport of RCA. A marker system for radiating a radio field in a vertical direction. Several "turnstile" antennas spaced a half wavelength apart, each antenna comprising several vertically disposed pairs of crossed horizontal dipoles, with means for establishing a phase quadrature relation between energizing currents for upper and lower dipoles of each turnstile lying in one plane with respect to energizing currents for dipoles lying in a plane perpendicular thereto.



UNIQUE PACKAGE

The Harvey Machine Company of Los Angeles is offering an inexpensive, light weight, 5-in-1 aircraft "package" which provides automatic directional flight control, radio compass, complete transmitter and receiver, complete receiver and left-right indicator for manual flying. Here's the way the equipment installs in a typical fuselage.



COMPACT REGULATOR

Small as a box camera, this new Westinghouse voltage regulator supplying current for the operation of aircraft radios and instruments weighs only 2 lb., functions perfectly at temperatures as low as 40 deg. below zero and at altitudes up to 35,000 ft.

No. 2,273,447, to R. S. Ohl of BTL, Inc. Means for producing a unidirective beam of energy comprising a cylindrical wave-guide having an internal diameter approximately 0.7 times the wavelength to be used, a paraboloid reflector having a diameter at its normal focal plane large with respect to the internal diameter of the wave guide, and a focusing lens having a diameter substantially equal to the diameter of the reflector at its normal focal plane.

No. 2,274,262, to Irving Wolff of RCA. Air speed indicating device. For indicating velocity by means of a source of sound waves, a pair of pickup devices and means for indicating the velocity of the medium passing the source as a function of the phase of the sound waves. Further, means for changing the frequency of the sound as a function of temperature to thereby indicate the velocity within limits independent of said temperature.

No. 2,275,298, to E. H. Hugenholtz of RCA. Course indicator. A device for indicating visually the deviation from a radio course of the complementary signal type which includes receiving the signals, transforming them into impulse signal combinations with the relative polarity of the impulse signals dependent upon the direction of deviation.

No. 2,275,296, to G. B. Hagen. A direction finder comprising a directive antenna, a second directive antenna angularly disposed with respect to the first and a non-directional antenna together with a radio receiver and a switching means for combining in successive order the currents of one of said directive antennas with the currents of the non-directive antenna.

No. 2,268,643, to M. G. Crosby, RCA. Distance determination. Means of frequency modulating a wave and for receiving the wave after reflection from an object whose distance is to be determined by converting the received frequency modulated wave into an amplitude modulated wave whereby the distance of the object is a function of the amplitude of the demodulated wave.

The last word . .

in wet seat grinding for Aircraft Radial Motors

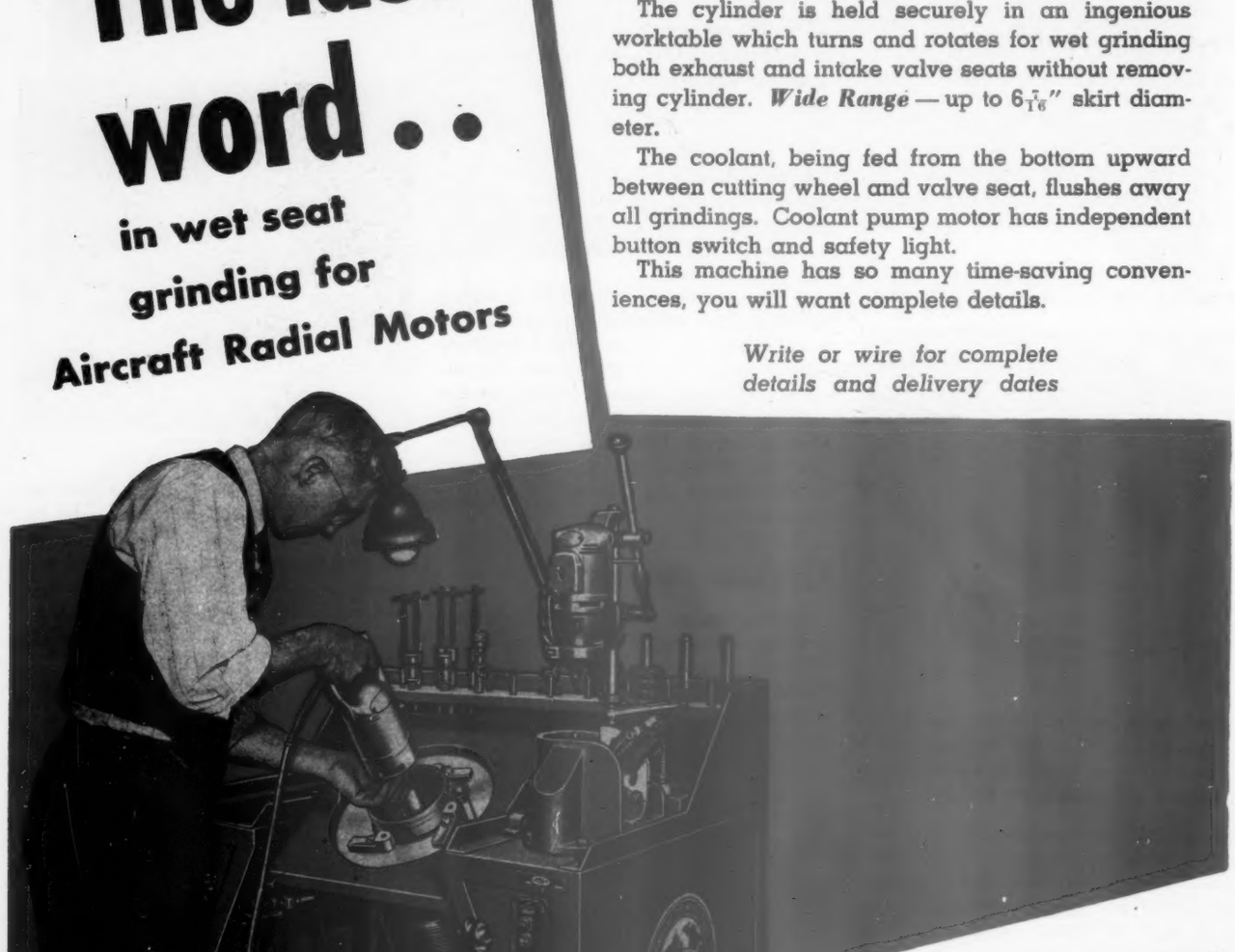
This new SIOUX development assures better finish and accuracy . . . eliminates wheel loading and scratching . . . reduces wheel dressing to a minimum. For compactness and efficiency it is the ***last word.***

The cylinder is held securely in an ingenious worktable which turns and rotates for wet grinding both exhaust and intake valve seats without removing cylinder. ***Wide Range*** — up to $6\frac{7}{16}$" skirt diameter.

The coolant, being fed from the bottom upward between cutting wheel and valve seat, flushes away all grindings. Coolant pump motor has independent button switch and safety light.

This machine has so many time-saving conveniences, you will want complete details.

Write or wire for complete details and delivery dates



SIOUX

AIRCRAFT WET VALVE SEAT GRINDING MACHINE

STANDARD THE WORLD OVER

ALBERTSON & CO. INC. SIOUX CITY, IOWA, U.S.A.

Civil Operation and Training

CAA Cites Need For Air Cleaners

Establishment of defense zones necessitating removal of flight operations to dusty, sandy and weedy airports has greatly increased engine wear due to dust and sand entering through the carburetor air intakes, especially on 4-cylinder horizontally opposed engines, the CAA reports in a safety bulletin citing the need for air cleaners or relocation of intakes and outlining rules for their installation.

Installation of an approved type requires only a notation by the mechanic, but for those not covered by a manufacturer's service bulletin, the CAA warns that a Repair and Alteration form in duplicate should be submitted to the local inspector for approval.

Relocation of the intake will help, but "when any changes are made in the induction system ahead of the carburetor, care should be taken to reduce pressure losses and carburetor air stratification in the intake duct," the bulletin points out. "The cross-sectional area of any portion of the intake should be at least equal to the opening at the entrance to the carburetor and bends, flattening and changes in sections of the duct should be avoided where possible; also the ducts, valves and connections should be capable of withstanding normal wear due to vibration, wide temperature variation, and explosive pressure such as obtained during an engine backfire."

CAP Responsibility Increases

Increasing value of CAP to the nation's war effort is recognized in word recently sent to all unit commanders from Washington indicating that the organization can soon expect to be called upon to assume new wartime missions.

Intimating that many members who heretofore have been engaged only in practice exercises will soon be assigned "active duty" roles, national headquarters reports CAP will be asked to furnish manpower for fly-away delivery of equipment now rolling off assembly lines ahead of schedule.

In line with expansion of CAP responsibilities, National Headquarters staff has been expanded. National Commander Earle L. Johnson has been promoted to rank of Major in the Army Air Forces and Capt. Gil Robb Wilson has been appointed chief consultant to the commander. He is relieved as commander of the First Region but will continue as Second Region commander pending appointment of a successor. Maj. Robert S. Fogg becomes commander of the First Region, comprising the six New England states.

Jack Vilas, former Illinois Wing commander has been called to Washington to become national executive officer. Lieut. James F. Broom has assumed operational duties; Lieut. Oscar C. Smith is to work with Henry Hawgood on fiscal matters and Gilbert Leigh, former Ark. wing commander has been named supply officer.

ON PATROL . . .

• *Success stories on which Army confidence* in CAP has been built continue to pile up.

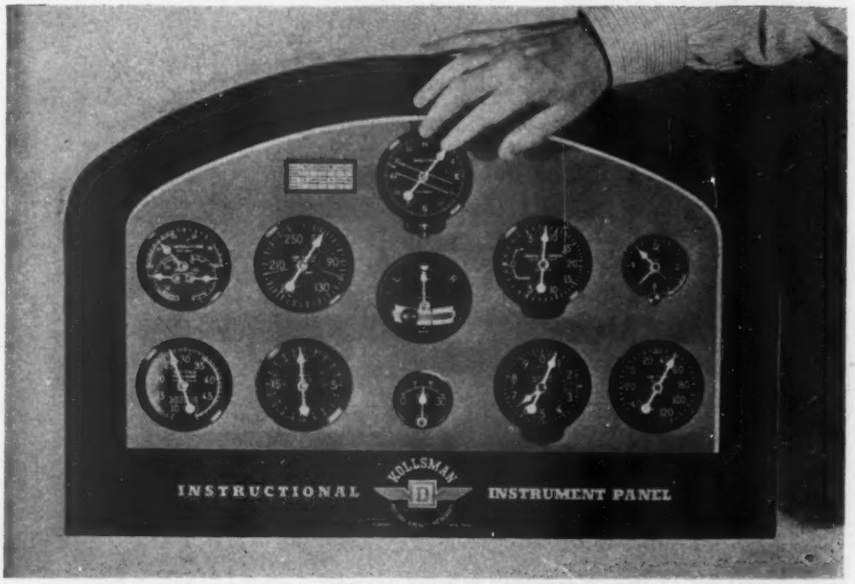
There were, for example, the two outstanding jobs by Oklahoma's wing following recent tornadoes. One which hit Pryor, Okla., killing 50 and injuring 100, had hardly gone through the town before planes from the Tulsa wing were in the air, ferrying doctors, nurses and sorely needed medical supplies. These were followed by other planes which made a complete survey on which Red Cross and government authorities based estimates for material and supply needs.

A week later the group was called upon to perform similar duties for nearby Pawhuska.

• *When Georgia and North Carolina* forest fires created so much smoke that detection of new blazes became impossible from ordinary lookout towers, CAP flyers took rangers aloft in radio equipped planes from which it was possible to direct fire fighters.

• *In Kansas* eleven planes participated in joint maneuvers with a mechanized Army unit in which the exercises were radio-directed from aircraft piloted by Wing Commander J. Howard Wilcox.

• *New England's CAP* has set a goal of 5,000 pilots and 1,400 planes to conduct all-important coastal patrols as well as watching over miles of vital power lines. and thousands of acres of forest lands. . . . *Cleveland's group* tackles the transportation problem by mapping location of every member so that at least five can get to drill in one car. . . . *Group 221, New York,* has established a Quartermaster Intermediate Depot at Roosevelt Field to assemble aircraft parts and other CAP material and make them available quickly and at minimum cost. Several group members made loans to start the depot and Procurement Officer J. C. Welsh has been interviewing manufacturers to secure their cooperation. . . . *St. Louis* has a women's squadron of 60, whose sole male member is



INSTRUMENT INSTRUCTION AID

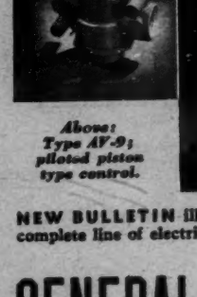
New dummy instrument panel being manufactured by Kollsman for instrument instruction. Since all pointers are movable, the instructor can set-up any problem and students can familiarize themselves with instrument interpretation without taking up flight time. The panel is rigid and easel-equipped with actual-size dials including direction indicator, engine gage unit, free air thermometer, manifold pressure, air speed, tachometer, bank and turn, clock, vertical speed, sensitive altimeter and ammeter.

hi-g*

GENERAL CONTROLS
ELECTRIC HIGH PRESSURE
HYDRAULIC VALVES

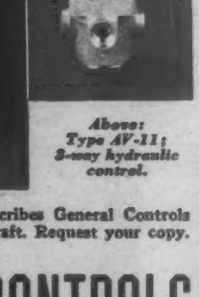
hi-g — Most important operating characteristic of ALL General Controls Aircraft Type Electric Valves is their positive ability to operate in any position, regardless of vibration, change of motion, or acceleration, i.e., substantial increases in "g." That's what we mean by hi-g.

Fast acting, positive operating, light-weight General Controls two-wire electric hydraulic valves are available to handle all fluids, vapors and gases up to 1500 lbs. or more. Available in normally open, normally closed, single seated types, as well as pilot piston operated types. These valves are designed for continuous or intermittent duty. General Controls 3- or 4-way types are for hydraulic control, proportioning, inching, or complicated selector valve arrangements.



Above: Type AV-9; piloted piston type control.

Below: Type AV-3; single seated, normally closed type.



Above: Type AV-11; 3-way hydraulic control.

NEW BULLETIN illustrates and describes General Controls complete line of electric valves for aircraft. Request your copy.

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PIONEERS AND LEADERS IN THE DEVELOPMENT AND MANUFACTURE OF MAGNETIC VALVES

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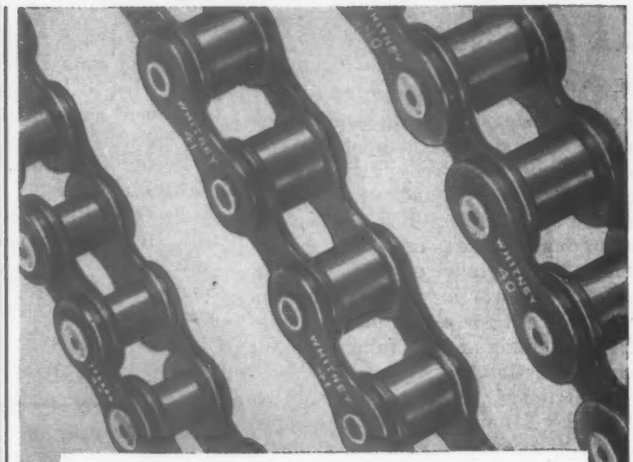

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Roller Chains

Fit Readily Into Plane-Design

Positive action of Whitney Roller Chains and Sprockets . . . plus their adaptability to varied design requirements, and their balanced construction which develops maximum strength per unit of chain-weight . . . these are important reasons why Whitney Roller Chains are widely specified for aircraft applications. Years of uninterrupted service on a wide range of machinery and mechanisms constitute a solid assurance to you of reliability in *your* application. Write.

The Whitney Chain & Mfg. Co.
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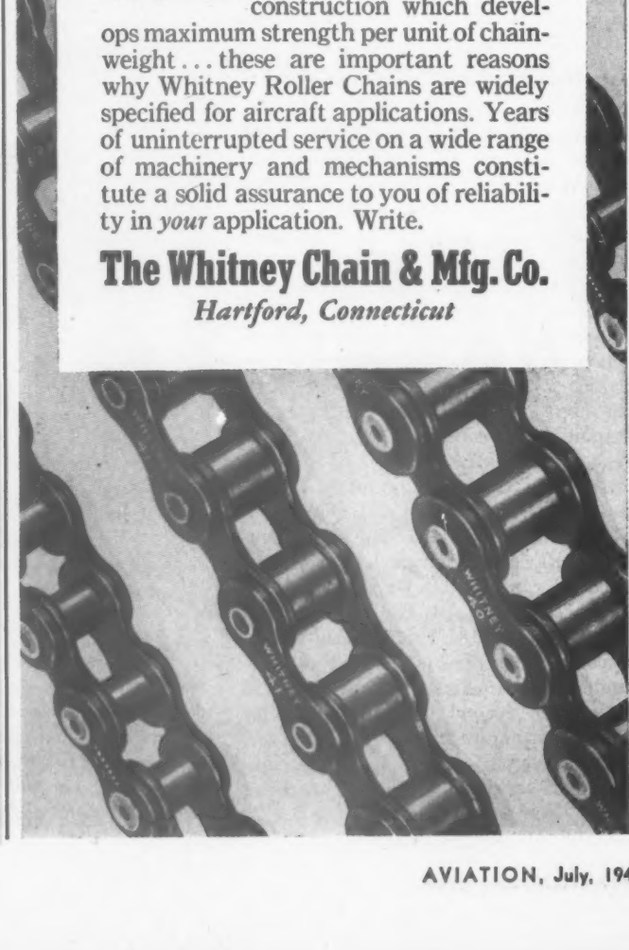


medical and personnel officer. . . . *California wing* now distributes over 3,000 copies of a sprightly looking printed publication called *Wing Tips*—other groups might well emulate enlisting cooperation of printers, engravers and paper companies. . . . *New Jersey's wing headquarters* have been established at 20 Washington Place, Newark.

CAA Issues Data on Instrument Approaches

To aid non-airline pilots in making instrument approaches to range-associated airports, CAA has issued, in booklet form, a table covering more than 200 airports outlining procedure to be followed for such approaches.

The table gives "a limited amount of information" but has been issued to give data which could not be made available in chart form within a year. The Administration also warns that "because of the rugged terrain adjacent to many of the range-associated airports, it is recommended that these tabulated data be supplemented by a thorough study of the pertinent aeronautical chart covering the area where an instrument let-down is proposed."

The table gives, in columnar form, the name and elevation of the airport, minimum safe initial approach altitude —in each case higher than that specified for airline pilots—direction of the final approach leg; direction and altitude of procedure turn; altitude over range on final approach; magnetic bearing and distance from the field; minimum safe let-down altitude; and instructions for missed approach procedure.

Jardur Flightmaster

Designed for pilots, an entirely different air navigation computor, called the Jardur 10 sec. Flightmaster, has just been brought out by **Jardur Import Co.**, 21 West 19th St., New York, N. Y. The Flightmaster solves the following problems quickly and easily: Radius of action, dead reckoning, triangle of velocities, moving (aircraft carrier) base, etc.

The directional navigation side determines air and ground speed, wind velocities, correction angle, magnetic and compass courses, and drift angle.

The reverse side includes conversion scales for Fahrenheit and Centigrade temperatures, land and nautical miles. The outer scale divides total distance in miles by ground speed in miles per hour to obtain elapsed time in hours and minutes; multiplies elapsed time in hours and minutes by consumption of gas per hour to get total consumption of fuel per trip. Inner scale corrects indicated air speed at variable elevations and temperatures to actual air speed. The Flightmaster also corrects for magnetic variation and wind correction in such a way that the magnetic course is obtained without any mental arithmetic. A mechanical "drawing board" solution for directional air navigation problems is provided which assists in a visualization of any particular problem, and maintains all data on the face of the instrument until the solution is reached, thus facilitating checking and avoidance of errors.

ALONG THE APRON . . .

• *War training has brought to Orangeburg,* a city of less than 10,000 population in South Carolina, an unusual concentration of aviation's "names" as members of the Hawthorne School of Aeronautics staff.

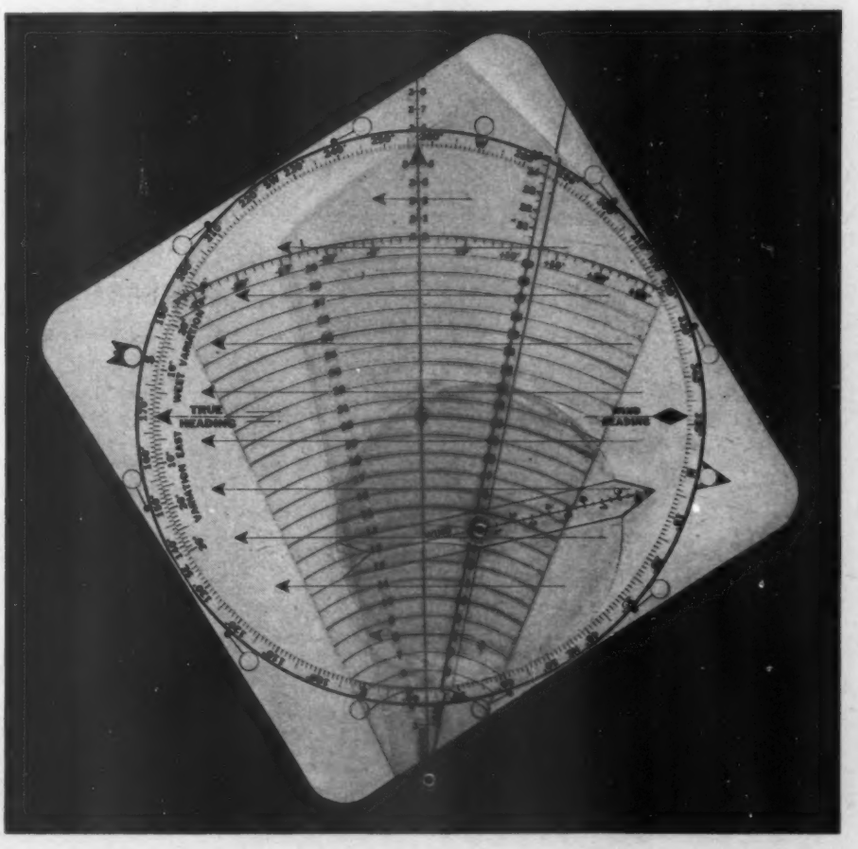
Heading this Army Air Corps Training Detachment is 27-year-old Beverly Howard, president of Hawthorne, one of the nation's outstanding aerobatic pilots whose light plane stunts made him a featured performer at air shows the country over, who still finds time from administrative duties to put his skill to good instructional use.

Sqdn. Comdr. Jimmy Granere, rated as one of the nation's ten top aerobatic pilots and well remembered at air races for the father-and-son performances he

put on with his father, the late Capt. Dick Granere, has turned to less exciting but more valuable work of teaching. Also doing their share of instructing are William G. Catron, former CAA director for Tennessee, who serves as director of flying for Hawthorne; Al Bennett who "has probably introduced flying to more people than any other person in the country" and William D. Strohmeier, former Piper official who was one of the group instrumental in introducing "grasshopper" observation planes during army maneuvers last summer.

Rounding out Orangeburg's "who's who" is Wolfgang Langewiesche, aerodynamics and applied flight authority and glider enthusiast who introduces cadets to theory of flight intricacies.

• *New staff members at Airport Ground Schools,* Los Angeles, include Dr. Earl Hill, CPTP head at the Univ. of So. Cal.; Dr. T. L. Wood, former state vocational supervisor; Paul E. Ruch, meteorology professor at Cal-Tech; Frank Arvidson; P. E. Peifer; Guy Ball and Wm. V. Mason.



ENLIST THESE KINNEAR FEATURES FOR TODAY'S *EXTRA* DOOR NEEDS!

WARTIME BUILDING STANDARDS

1. PROTECTION . . . . .
Kinnear's rugged, all-steel construction prevents theft or intrusion, resists saboteurs or accidental damage. Defies wind, weather—even closes light tight for blackout safety!

2. MOTOR OPERATION!
Motorized doors provide smooth, rapid, dependable operation at all times. Available with every Kinnear Rolling Door!

3. REMOTE CONTROL! . .
Important savings in time and labor can be made by providing pushbutton door control at any number of strategic points.

4. SAVE SPACE! . . . .
All floor, wall and ceiling space around the door remains usable at all times! By providing extra storage or working room, they help keep production rolling at top speed!

5. FIRE SAFETY! . . . .
Kinnear's interlocking steel-slat curtain is highly resistant to fire. (Fire*proof* closure may be had with automatic Kinnear "Akbar" Rolling Fire Doors.)

6. OPEN OUT of the WAY!
The doors coil into a small space above the lintel, are always out of reach of damage, never hinder traffic or other plant operations!

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Kinnear's tough, all-steel construction stands up under today's hard, punishing, night-and-day service!

8. QUICK, EASY REPAIR!
Any number of slats can be replaced quickly and easily. Any and all parts are replaceable at any time!

INSTALLATION PROBLEMS ARE AVOIDED!

Kinnear Rolling Doors are built any size for any building, and are engineered to fit the individual openings. Economy of installation is assured! Or, if you prefer, Kinnear's nationwide service organization will relieve you of the installation job entirely! Write today for recommendations, or ask for a copy of the new complete catalog on Kinnear Rolling Doors! We'll gladly send you a free copy, without obligation.

SAVING WAYS IN DOORWAYS **KINNEAR** ROLLING DOORS

The KINNEAR MANUFACTURING *Company*
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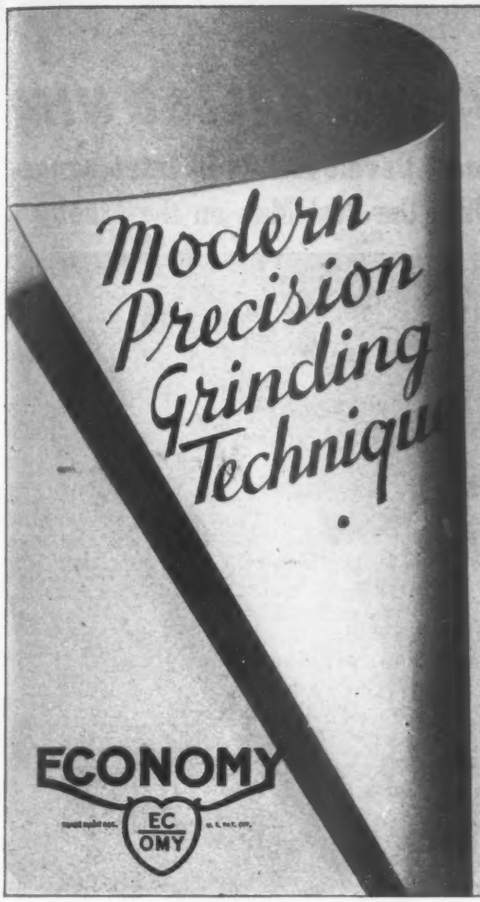

Here's How Economy Grinding Oil will help you to meet production

Economy Grinding Oil is completely revolutionizing the technique of grinding operation.

Economy Grinding Oil gives you definite reduction in temperature at the interface of wheel and work.

Economy Grinding Oil allows reduction in pressure between wheel and work because of increase in lubrication and penetration of the coolant.

Economy Grinding Oil makes it possible to reduce grit size from 60 to as small as 180 to 240 and still maintain free cutting and greater accuracy of form and contour.

Economy Grinding Oil is now used extensively and successfully in thread and worm grinding, bevel and spur gear grinding, spline grinding, and certain pertinent surface and cylindrical operations.

Results never before produced in grinding.

New catalog E-17 well worth having. Yours for the asking.

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CHAMPION *Ceramic Aircraft* SPARK PLUGS

MORE VITAL—MORE DEPENDABLE THAN EVER

Champion ceramic insulated spark plugs are setting new and amazing records for top performance, absolute dependability and long life in engines of all types and sizes. The extreme efficiency of these Champion Spark Plugs is directly due to their revolutionary ceramic insulators—the product of extensive research into the specific requirements of aircraft engines.

The C 26 (unshielded) and C 26 S (shielded) types cover a very wide range of engines in all but the highest output category. Special types for the most advanced high output military engines likewise embody the same specially developed ceramic insulation.

Champion ceramic insulation has these characteristic advantages: (1) Immunity from heat and chemical reactions. (2) Freedom from fuel, oil or moisture absorption which brings on "shorts". (3) Inherent high heat conductivity with consequent wider range between pre-ignition and fouling. (4) Absolute uniformity of material. (5) Thicker sections, elimination of air space, cut down current loss. (6) Easily cleaned and serviced—no specialized equipment or factory return necessary. (7) Scientifically controlled manufacture.

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but BLACKHAWK'S Newest Developments in Interchangeable Socket Wrenches Made Him the Best Man on the Line!

Here's a Tip on How to Speed Up Your Production

DON'T let your men struggle with misfit wrenches, big-jawed adjustable and out-of-date open-enders. Give 'em *completely interchangeable* Blackhawk sockets, attachments and handles that click together in a jiffy into one solid tool. No need to waste time making special wrenches, either — when one 50-piece set of standard BLACKHAWK SOCKET WRENCHES makes more than 23,000 combinations — for just the right leverage to speed up any "tight spot" job. They're expressly engineered for faster, better work on the most complicated assembly, service and maintenance jobs — that's why they get the nod in leading aircraft and other plants on war production. Features include famous "LOCK-ON"; extra tough thin wall sockets; Gripline handles; free-wheeling ratchets; slim, trim design, and special analysis steels for light weight plus exceptional strength. For the latest information on solving nut and bolt problems requiring wrench openings of 3/16" to 3-1/2", call your Blackhawk Industrial Supply Distributor — or write us for free copy of 48-page "HANDY GUIDE", describing the full lineup of 185 sockets, handles, attachments, torque indicators and specialties.

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Dept. W2172 Milwaukee, Wis.

Aviation's Divergent Trends

By SELIG ALTSCHUL

A SURGE of optimism that the war may soon be at an end, has been attributed as the cause of divergent trends of "war" and "peace" stocks. The aviation industry is in the anomalous position of having outstanding participants in each of these categories—aircraft manufacturing and air transportation.

It would indeed be a welcome harbinger of the times to be able to say that because airline equities are strong and aircraft issues weak, peace may soon be around the corner. Unfortunately, such is not the case.

Based on past performances, the stock market has proved to be a far superior forecaster of events than say, astrology or any Nostradamus. Whenever this department speaks of the market, there is no desire to encourage stock speculation: the only interest is to ascertain trends as revealed by this barometer. Collective opinion—substantiated by hard cash—is best mirrored in the market place and prices soon reflect the trend of what usually proves to be the best-informed thinking. As economic and social structures become more involved, proper interpretation of market trends becomes equally more complex.

It is this observer's belief that informed opinion, as reflected in the market, is very much in a quandary as to determining the essentially unknowable duration of the war. Divergent trends, at present, can be explained in one term—taxes. It so happens that aircraft and other so-called war companies are hit the hardest by present tax policies. On the other hand, most companies in the "peace" category, while not invulnerable to reduced earnings, find their taxation less onerous. It is equally true that while the post-war outlook for the aircraft builders is not so sanguine, the air transports are heralded with a brilliant future, albeit with an uncertain present. The various elements surrounding each of the aviation groups will be presently examined.

In passing, it can be noted that the conclusion of hostilities—the sooner the better—will probably exercise a major constructive influence on the broad stock list. This will simply state that the outlook for American industry has immeasurably improved. The coming of peace would mean more tolerable taxation, absence of priority troubles, end of rationing and the release of all those restraints and restrictions which are the concomitants of a war economy. Free enterprise and individual initiative would once again become dominating influences. As the war extends in duration, government controls will become more involved and intricate and it may become increasingly more difficult to restore the American economy to its once free-functioning status. In other words, an early peace will be universally constructive for all segments of industry and will hurt no one. Yes, even the aircraft builders may find their lot improved.

Taxes Hard on Aircrafts

The pressure of taxes and other unduly harsh profit restraints appear to be the major causes for weakness in aircraft equities. Tax developments have been thoroughly discussed in previous issues (AVIATION—Nov. 1941, April 1942, June 1942). While probably the least glamorous, the tax question is undoubtedly the most important element confronting the aircraft industry at the moment.

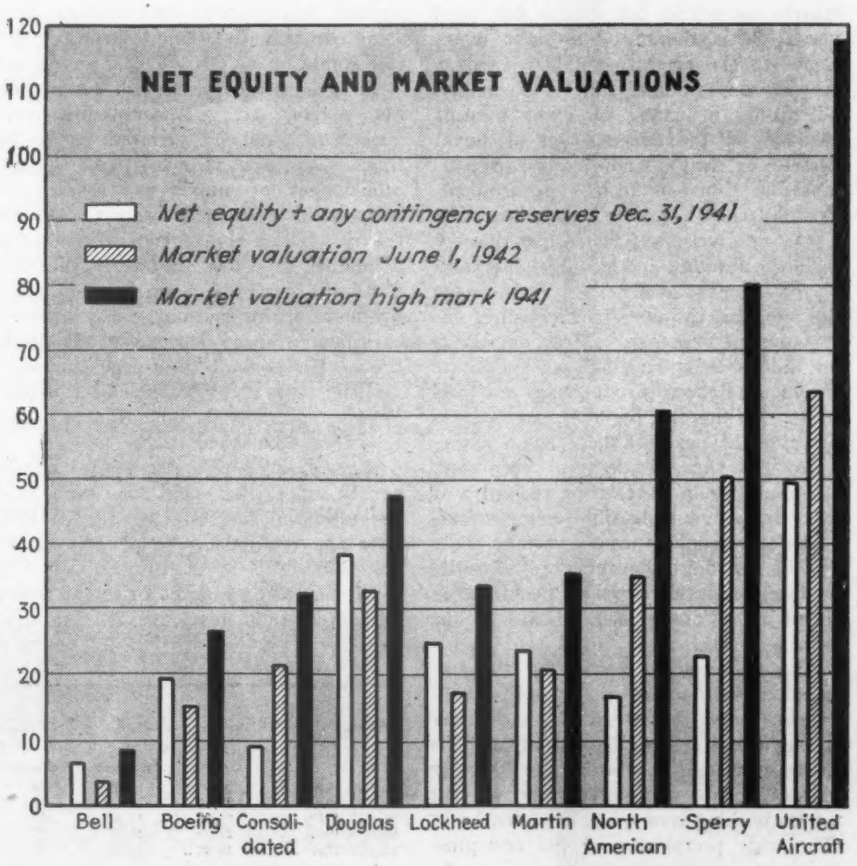
The current prospectus of the corporate tax bill as presently visualized by the House Ways and Means Committee, calls for a normal and surtax rate of 40 percent and an excess profits tax rate of 94 percent. There is also a good possibility that the final law may allow a post-war return of all excess profits taxes paid beyond 80c. on each dollar of excess profits paid. Such rebates could prove to be tremendously important to the aircraft industry which has a huge excess profits tax bill and a post-war problem.

TABLE I—NET EQUITY AND MARKET VALUATIONS

Representative Aircraft Companies

	Net Equity + Any Contingency Reserves Dec. 31, 1941	Market Valuation June 1, 1942	Market Valuation High Mark 1941
Bell	$6,638,375	$3,948,263	$8,650,688
Boeing	19,359,327	15,146,096	26,776,134
Consolidated	9,242,726*	21,190,026	32,427,161
Douglas	38,422,598*	32,850,000	47,550,000
Lockheed	24,940,779	17,349,855	33,623,750
Martin	23,640,359	20,646,919	35,512,700
North American	16,787,389	35,209,088	60,542,246
Sperry	22,831,222	50,389,125	80,118,709
United Aircraft	49,721,137	63,760,584†	117,890,663

*As of November 30, 1941.
†Common stock market valuation only.



This may be one method of providing the incentive so necessary to obtain the utmost from our production program. The British have this plan in operation. It is likely that should it be adopted, a number of strings may be attached to the uses in which this credit may be used. Probably, the companies will be required to spend these post-war rebates for plant facilities and employment of labor and prohibited from paying dividends to the owners. This was the pattern followed in England until all conditions were reduced to one—the lone restriction being the prevention of paying dividends.

As presently constituted, the tax bill makes it virtually impossible for any aircraft company to exceed previous year's earnings. In fact, despite the huge increase in sales volume, the earnings for most aircraft companies may be lower than in 1941 and at the levels prevailing in 1939 and 1940.

Due to the many shifting factors and military cloak of secrecy surrounding aircraft operations, a projection of the effect of the proposed tax measure is futile and meaningless. Further, as indicated last month, voluntary price reductions and switching from fixed-price to cost-plus-fixed-fee contracts, not only serve to reduce corporate earnings but complicate any possible projections.

The Treasury Department has also indicated that it will now become more stringent in disallowing certain expenditures deductible for income tax purposes. This should be no new experience to the aircraft builders. Under the Vinson-Trammel Act, as amended, all profits in excess of eight percent realized on the construction of naval vessels or Navy and Army aircraft, must be returned to the government. The Treasury has, as a result, issued its Treasury Decision 5,000 which clearly defines allowable and disallowable costs on government contracts. Those costs not recognized include advertising, entertainment expenses, interest on bonded indebtedness and federal and state income and excess-profits taxes and surtaxes. While the limit on earnings is set at eight percent, there is no assurance that such results will eventuate. As a matter of fact, with federal and state taxes not deductible, net earnings of eight percent on sales are impossible. No longer does the industry have its former profitable foreign bookings to offset limitations present in sales to our own services.

This is another reason for the tremendous shift to cost-plus-fixed-fee contracts from the previous fixed-price arrangement. Tangible proof of this transformation is afforded by Douglas Aircraft with more than 90 percent of its backlog now on a fixed-fee basis. The wide popularity of the cost-plus-fixed-fee contract is due to its virtual guarantee against loss to the contractor. The government, in effect, buys and supplies the materials and pays the labor. The company merely manages the enterprise for a fee.

While this may appear to be a simple expedient in guarding against profiteering, the most desirable results may not always occur. No incentive whatsoever is present to promote more efficient and economical operations. With the profit motive gone and all "excess" earnings absorbed by taxes, resistance to increased expenses is decidedly lessened, and all sorts of expenditures can run riot with the government footing the bill. The post-war rebate may be one answer.

Such are the broad problems surrounding the aircraft industry today. Now, how about this post-war uncertainty facing the aircraft builders which seems to be troubling everyone? Obviously, no one can pierce the vale of the future and glibly trace with any precision the step-by-step developments to follow. But the world is not going to come to an end for the old-line aircraft builders nor are they going to be swallowed up by the automobile combines.

Financial Strength Revealed

Everything must be examined in its proper perspective. When the shooting is all over, it will be found that the aircraft builders will come through with small capitalizations and a strong financial condition.

In penetrating the annual reports of the various aircraft companies, evidences of financial strength come to light. The past year has seen the establishment of numerous reserves to help cushion the adjustments of the future. These contingency reserves, in a number of cases, are rather substantial and are being constantly augmented by new appropriations from current earnings. As of December 31, 1941, the most important "nest-eggs" included United Aircraft $10,000,000, Curtiss-Wright $7,230,000 and Boeing and Lockheed $3,500,000 each.

Aircraft prices in the market place hardly reflect the boom conditions now prevailing in the industry nor do they have any relationship to present equity values.

In comparing market prices of today with those of a year ago, for example, some startling price disparities are revealed. Looking at a market price not as a mere quotation but as the total valuation placed upon a company, it is possible to make a number of interesting comparisons. Table I shows the total equity or net worth position plus any contingency reserves for a number of major aircraft companies as of December 31, 1941, along with the total market evaluation as of June 1, 1942 and at the high mark of 1941. These contrasts are even more startling when it is realized that market prices for aircraft equities were at materially higher levels in years prior to 1941.

It can be seen that market valuations in all cases are not only substantially reduced from a year ago but in many instances are actually below the present net worth or equity position of the companies involved. Net worth position is not the sole criterion in evaluating companies, but it is an important element. Other major considerations are also involved, particularly earning power, which may explain certain disparities existing in the market evaluations within the industry.

Undoubtedly the market is also attempting to evaluate the potential competition from the automobile combines. There has been much comment of late anent this future struggle. Based on the record thus far, the old-line aircraft builders have shown the most outstanding pioneering in manufacturing technique. Certainly such abilities will not be at a disadvantage when markets become more competitive.

Further, not all present airplane producers need continue in the business if the demand does not exist. Equipped to do virtually any kind of metal work, many of the present companies can enter new fields on a profitable basis. Their financial positions should greatly facilitate such transformations.

The post-war market also appears to be taking on expanding attributes in both military and commercial potentialities which should prove to be great sustaining influence. In any event, present aircraft market values are not of a lush era but appear to have gone a long way in discounting many of the unknowns of the future.

Airlines in Own Trend

The airlines are passing through a cycle of their own. Despite seemingly depressing news, air transport equities have rebounded from the lows established a few months ago.

While much commercial business will be lost by the industry, it is unlikely that the carriers will incur any deficits in their war operations. Many services are being conducted by the airlines under contract for the Army. The carriers

(*Turn to page* 292)

TABLE II—BARRON'S STOCK AVERAGES

	Aircraft	Air Transport	50 Stocks
May 29, 1942.....	26.92	16.88	58
May 22, 1942.....	25.70	16.50	58
May 15, 1942.....	26.02	14.47	57
May 8, 1942.....	27.38	15.47	57
May 29, 1941.....	35.02	18 81	66

ARCHIMEDES: *287-212* B. C., *most celebrated of ancient scientists—the first of many famous engineering minds to think constructively on the subject of hydraulics.*

the Pump with a BRAIN

The Dowty *Live-Line* Pump "thinks" for itself—functions automatically without need of auxiliary equipment required to control conventional pumps. Through incorporation of an actuating "brain" in the basic design of this unit, Dowty accomplishes manifold desirable results. In fact, the Dowty *Live-Line* Pump is the *only* hydraulic pump in quantity production which offers all the following advantages—*eliminates up to three separate accessories in the hydraulic system . . . minimizes plumbing and the possibility of oil leakage . . . lessens military vulnerability . . . simplifies installation, operation and maintenance . . . saves weight.*

Our engineering department will gladly furnish complete information upon request.

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WING FLOATS
•
WING FOLDING MECHANISM
•
REMOTE FUEL PUMPS
•
GUN TURRETS
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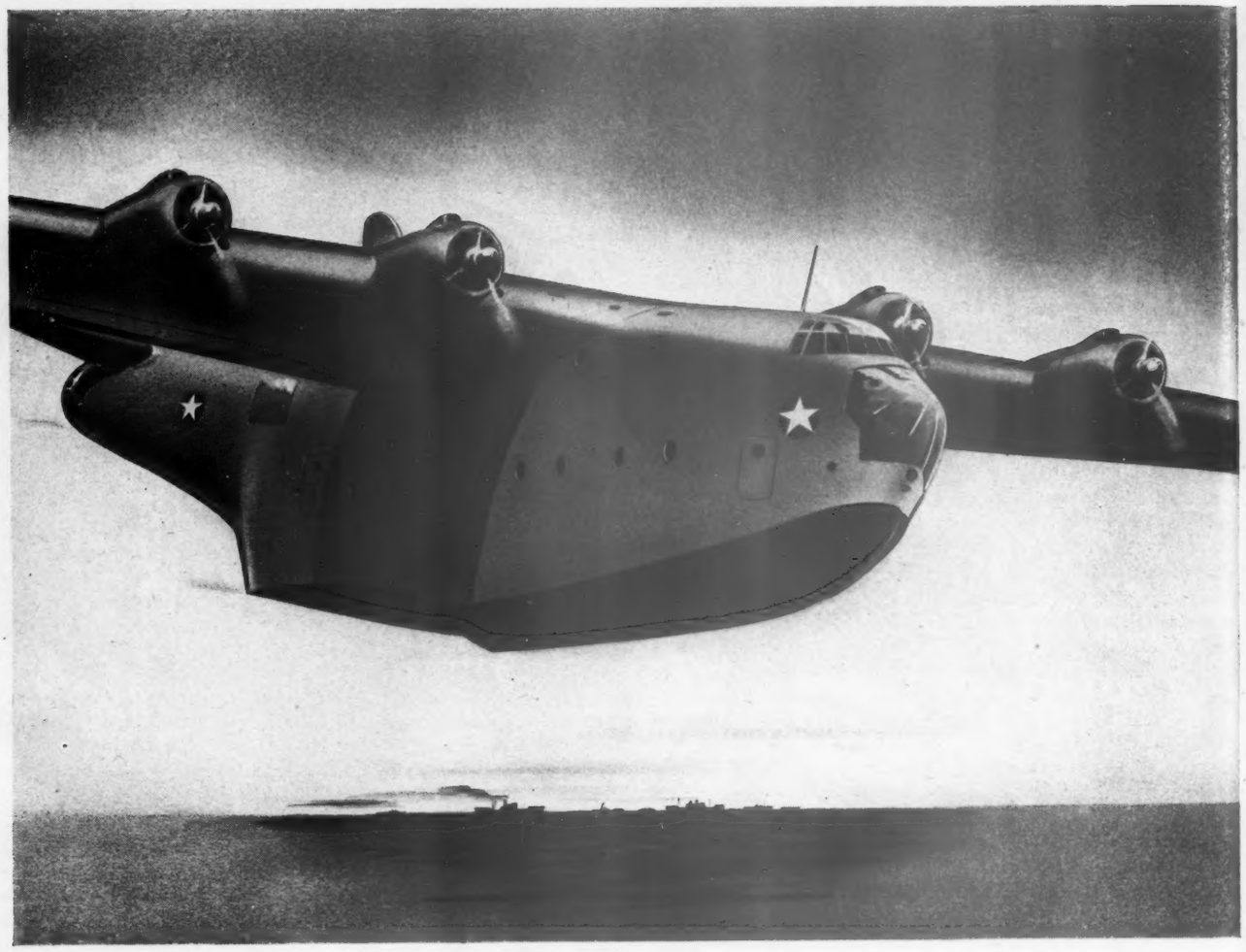
BOMB DOORS

SPECIALISTS IN LANDING GEAR & HYDRAULIC EQUIPMENT FOR AIRCRAFT



PROPELLERS
FOR THE
Martin Mars

Successful flight tests of the 70-ton Martin Mars will soon add to the United States Navy the services of the largest flying boat in the world. Seventeen foot Hamilton Standard Hydromatic propellers now harness the eight thousand horsepower which drives this great airplane.

HAMILTON STANDARD PROPELLERS

One of the three divisions of

UNITED AIRCRAFT CORPORATION
EAST HARTFORD, CONNECTICUT

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington C. B. F. MACAULEY, New York RANDOLPH HAWTHORNE, New York E. EUGENE MILLER, New York

Army Air Force Will Operate Over Europe As U. S. Units Cooperating With British AAF Will Have 1,000,000 Men by Year End

Washington (AVIATION Bureau)—Upon his return from an allied conference in England, Lieut.-Gen. Henry H. Arnold, chief of the Army Air Forces, stated that American pilots will fly American equipment, organized as AAF units, in the forthcoming Anglo-American air attack on Nazi Europe.

Allocation of American aircraft as between the British and the AEF, is being made with this plan in mind. This means that all types of craft necessary for complete task units are being held for the AAF now assembling in the British Isles. But Britain will get American planes as usual.

Gen. Arnold stated that no combat planes are being held in the United States except those necessary for tactical training.

Army and Navy Journal recalls that Gen. Pershing had to fight to keep the American Army intact, in the first World War, against French demands for a merger. That instance may have guided Arnold in retaining unity for his air forces.

Speaking before the graduating class, Iowa Wesleyan College recently, Gen. Arnold said that American flyers are getting more actual hours of training than those of any other country.

He said that when our pilots have anything like equality in the air against the Japanese, they "blast them out of the sky." So far, our record is about four to one, he stated.

By the end of this year, the General said, the Air Force will have more than 60,000 officers and close to a million men. By June in 1943, if necessary, we will double those figures.

Assuring his hearers that the President's 1942 schedule of 60,000 planes is being met, the air chief said that we have standardized our plane models which have proved successful in combat. Quantity production more than offsets any temporary advantage secured with a few radical new designs. We are getting quality and quantity both. He mentioned that gliders are taking part in AAF plans.

The General described performance of several American plane types in critical fights, mentioning especially the B-17's and the B-25's. The latter, he said, have exceptionally long range. He said the raid on Japan had returned "in kind—with interest" the death and destruction dealt by the Japs to American forces. This would seem to mean that damage and casualties in Japan were heavy.

Air General Appointed Chief of G-3

Brig. Gen. Idwal H. Edwards, former Commanding Officer of Randolph Field, Tex., and more recently in service in the Organization and Training Division (G-3), War Department General Staff, has been appointed chief of that division. He succeeds Maj. Gen. Harold R. Bull.

General Edwards became a pilot in 1918 and has continued to serve in the Air Corps, being rated as a Command Pilot and Combat Observer. He was graduated from the Command and General Staff School in 1935 and Army War College in 1938, after which he was assigned to G-3. In 1940 he became Commanding Officer of Randolph Field, and the Air Corps Basic Flying School there. He returned to the Organization and Training Division of the General Staff in March, 1942.

BRIG.-GEN. I. H. EDWARDS, the new chief of Organization and Training Division, (G-3).

Men 27 to 37 Wanted

Men between 27 and 37 who have been selected by CAA for civil pilot training are authorized for enlistment in the AAF Enlisted Reserve. You should submit to an Army recruiting officer a certificate signed by a regional superintendent of CPT, noting your acceptance for this training, evidence of birth and citizenship and appropriate physical examination forms. Similar reserve enlistments are open to men between 18 and 27 who have been disqualified by Aviation Cadet examining boards.

We Hit Midway Japs Mostly With Planes

Point to notice about the great battle at Midway Island, 2,250 miles from Yokahama, is that all American reports, up to this writing, indicate that all of the damage to the Japanese fleet was done by airplanes. If this is true it is a significant point in the history of warfare.

Jap reports, however, claim large American fleet losses, which if true, would seem to mean that our ships were engaged.

Probably we shall have to wait some time to learn the facts. Some commentators go so far as to say that Japan has now lost *all* of her aircraft carriers—the total appeared to be eight regular carriers. This report may be far from true. In any case, the Japanese are converting many transport and other vessels to carry and operate airplanes from flat decks. Meanwhile, congressmen are talking for more carriers, with all speed. Of course the Navy says nothing.

Army Sets Up New Airline Priority System Public Still Rides if Space is Available

Washington (AVIATION Bureau)—Procedure for rationing of airline seats and cargo space to war business has been set up by the War Department.

In a word, the system provides priorities for several classes of war travel and cargo, and it leaves the John Q. Public travelers to make their reservations and fly as they always have—if they can get space. (See background story, Page 276.)

Because the rationing of airplane space and the semi-military work of the airlines make it a war operation, the Army is in control. For administration of the new program the War Department has transferred priorities on airlines to a new Air Division of the Transport Service, of the Army Services of Supply, which, you may recall, is one of the three parts of the newly-organized Army. Ray Ireland is chief of the Air Division.

The Air Division will establish the priorities in general; then the Military Director of Civil Aviation (Gen. Donald Connolly) will issue directives to the airlines.

Actually, applications for priorities will be handled by representatives of the Air Transport Association, which serves as liaison between the government and the airlines. There will be an ATA man in every city that has airline service; in most cases he will be an employee of the airlines, doing two jobs.

In most cases these ATA men will decide for themselves concerning the credentials of applicants for priorities, but if contact must be made with the Air Division it will not be necessary to wire Washington. The division will have offices in New York, Washington, Miami, Memphis, Dallas,

Kansas City, Chicago, Detroit, Pittsburgh, Los Angeles, San Francisco, Seattle, Denver, and Dayton.

Priorities are classified as follows: (1) White House personnel including Army and Navy; (2) Army, Navy and Marine ferrying commands; (3) military and civilian personnel specifically ordered by department heads to travel by air; (4) military equipment, ammunition, supplies essential to expedite war production.

Non-priority passengers and express are subject to cancellation before the flight begins or at any point along the route. Priority persons or goods may be put off for higher ratings. Mail will continue as is for the time being.

Current Air Training Programs Summarized

Several air training programs vital to defeat of the Axis were in progress at this writing.

1. Two courses of special training for staff officers of the Air Force and Armored Force will be inaugurated July 11.

2. Senate Military Affairs Committee approved a bill to increase the number of pilots in the AAF. The measure would create a new class of non-commissioned pilots — "Flight Officers"—who would have the rank, pay and allowances given to junior grade warrant officers. There is no limit on the number of flight officers to be appointed.

3. CAA and Navy have reached agreements whereby 20,000 members of the Naval Reserve will be given flight instruction at CAA pilot training centers. The group will include both full-time trainees and college students taking flight instruction on an extra curricular basis.

4. CAA announced that ground school instruction will be offered free to secondary school teachers who plan to teach aviation courses of preflight aeronautics. Over 600 colleges will accept registration of teachers in CAA's summer pilot training program.

5. The American aircraft industry offers to Army Air Forces mechanics a post-graduate course of one month in the airplane and engine plants. About 40 factories have already begun. Women mechanics will receive training at the first Army-operated training school for women, opened in Alabama. They will relieve male mechanics for field duty.

6. Nine AAF officers discussed flying training plans with representatives of the United Nations at a meeting in Ottawa. Purpose was to further united military efforts and extend the air programs.

7. Hundreds of Netherlands soldiers are being trained at four AAF establishments.

8. The CAA and Army are urging civil pilots who are physically unfit to fly combat planes to enlist in the Army's new glider force. Glider units are adjunct to the airborne fighting command and are designed to work in cooperation with parachute troops.

WPB Appoints Committee on Cargo Planes Several Types Available for Production

Army and Navy are deeply impressed with work done by cargo planes here and on all fronts. This fact, plus the shortage of shipping to serve the United Nations war effort, has inspired the War Production Board to study the merits of a vast air cargo program.

Donald Nelson has appointed a Committee on Cargo Planes, which will consider the use of large, long-range planes to carry loads of all kinds. Harold E. Talbott, deputy director of WPB's Production Division, once president of Dayton Wright Aircraft, is chairman. T. P. Wright and other aviation and government officials are members.

Several four-engine airplanes already in the air which could be produced in quantities sufficient to transport large tonnages could be built within a year or two. Then, if the war went on, types now on blueprint, like Martin's six-engine 250,000-lb. leviathan, could be built. Thus it is a question of time how far the air cargo project will be carried for war purposes. All authorities agree that merchant air shipping after the war will be developed on a world scale.

Pan American Airways reports that 5,000 persons were rescued from Jap battlefields in the East in 21-passenger planes, which, stripped down, carried 60 passengers each, bringing 6,000 to 8,000 lb. of cargo each on return trips. Each plane carried as many as 400 people in one night. This was done in weather so bad the Jap fighters could not come out to attack.

Army officers say the amount of materials being moved here and on various fronts is almost unbelievable. Multiple trips by the airplane more than make up for its small capacity as compared with trucks, rail cars or ships.

Chiang Kai-shek has just announced that China has passed her great crisis. What he probably means is that though all supply roads and ports be closed, he will get sufficient goods to carry on the war.

As usual, we have regrets.

Press Association, Inc. Photo

HAROLD E. TALBOTT heads Committee on Cargo Planes

If some supermind had envisioned our ship shortage and the possibilities of airplanes, this war could have been a walkaway. Germany figured better than we did, authorities say, providing transport and bombers on a ration of one to one or thereabout.

200 Navy Blimps

Diminished enemy submarine activity in the Gulf of Mexico is proof that the United States is winning the battle of the sealanes, and that lighter-than-air craft are rendering a worthwhile service in the anti-submarine program. Legislation authorizing an increase from 48 to 72 of Navy's lighter-than-air craft was recently approved by the House Naval Affairs Committee. The bill as passed by the Senate specified a total of 72 craft, but Chairman Vinson told the House that the Navy had asked that the figure be increased to 200. The House has approved that amendment. A second amendment was approved eliminating the word "non-rigid" from the bill, which means that the Navy, under the House version of the bill, may construct or acquire both dirigibles and blimps.

Aeronca Converted To Training Glider

Aeronca Aircraft Corporation has converted its *Defender* Trainer to a three-place glider. The same wing section and fuselage is used, with a modified version of the Aeronca landing gear. In place of the motor, a special nose section has been designed for attachment at the fire-wall, incorporating a seat for the pilot. The company announces it will soon go into mass production of the glider.

At the same time informed persons said in Washington that Taylorcraft also had completed a conversion to gliders, and that the Army is ordering a substantial number of both Aeronca and Taylor. The same sources said that the Army will use the gliders for primary glider training, and that part of this training will be done with powered craft of the same types, using the simulated forced landing technique, with power off.

The Aeronca glider can be flown from any one of the three seats, thus making it possible for the pilot to check two students at the same time. A special skid on the nose will enable the pilot to apply the brakes and put the ship on its nose to stop it in small fields. Wing loading is fairly high.

Charles Stanton, CAA administrator, is credited with having worked out the original idea of the converted glider.

Devins to Head Public Relations at Bendix

J. H. Devins, former public relations and publicity director of J. Stirling Getchell Agency in Detroit is now director of public relations for Bendix Aviation Corp. H. L. Sharlock is now director of advertising for the company in South Bend. Ind.

Devins was one-time eastern manager of the National Broadcasting Company press dept. and assistant manager of the radio company's nationwide set-up.

AAF Organizes a Safety Program

The United States Army Air Force is the safest military flying organization in the world, the War Department announces. Lieut.-Gen. H. H. Arnold, chief of the Air Force, says its pilots get more hours of training than any other military pilots. But it's not safe enough.

U. S. Army Air Forces Photo

COL. SAMUEL R. HARRIS, JR., newly appointed director of flying safety for the AAF.

To make it safer, AAF has appointed regional safety directors and ten Safety Regions have been created. At the same time, Lieut.-Col. Samuel R. Harris, Jr., newly appointed director of flying safety, has been promoted to the grade of Colonel.

Col. Harris says that the AAF accident rate is 10 percent lower than the average for the ten years 1930-1940. There is a large increase in the number of accidents, but that is due to the vast increase in the amount of flying. AAF intends to maintain the present low rate, despite constantly increasing total hours of flying. Col. Harris says that only 14 percent of accidents are due to mechanical failures; all the rest are human failures.

Jimmie Taylor Killed In Crash

Lieut.-Comdr. James B. (Jimmie) Taylor, rated as one of the country's outstanding test pilots, was killed in the crash of a small Navy plane near Woodbury, N. J. He had been stationed at the Philadelphia Navy Yard, and at the time of the accident was on a routine flight, according to the announcement by the Fourth Naval District.

Havens On Active Duty

Beckwith Havens, America's first airplane salesman and a flyer since 1911 has gone on active duty in the Navy as Lieutenant Commander, stationed at Floyd Bennett Filed. During the last World War, Havens was chief pilot at Anacostia, D. C., and also served as flying boat instructor at Hampton Roads, Va.

American Export Asked To Sever Airline

A Civil Aeronautics Board examiner, J. Francis Reilly, recommended recently that American Export Lines, the steamship company, be ordered to divest itself of control of American Export Airlines within a "reasonable" time after the war is terminated. Reilly contends that American Export does not plan to use the airlines in connection with its ship operation, which he says is required by the law. The recommendation will be reviewed by the board. Briefs will be filed, and presumably American Export will seek to justify the relationship, as it has already done.

G. E. Welding Expert to Address EAPF

Mr. Edward Vom Steeg, foremost welding authority and consultant for the General Electric Company will speak to the Eastern Aircraft Production Forum on the subject of aircraft welding at the GE air-conditioned auditorium, 570 Lexington Ave, New York on July 31, at 8:15 P.M. Also included in the program will be the showing of some of the skillfully produced GE welding training films. These films, in color, have caused widespread comment because of their technical excellence and instructive value.

The speaker, Mr. Vom Steeg, is a charter member of the American Welding Society, and has held many offices in that group. His contact with the aeronautical industry has been extensive, and he will cover his subject with considerable authority. His talk will be followed by an open question and answer session.

The Eastern Aircraft Production Forum has been performing a valuable function for over two years, serving as an organized meeting place for men engaged in the vital task of producing the nation's airplanes. The meetings are generally characterized by one or two talks by authoritative speakers on subjects of interest to production men, after which questions are answered by these authorities. Forum attendance and membership is restricted to people directly engaged in the technical responsibilities of aircraft production.

P & W-Buick Engines Scrambled—Okay

United Aircraft officials reveal that, months ago, after suggesting to the Army that the auto industry be brought into the aircraft engine field, a remarkable test was made on two engines.

Designs and "know how" had been loaned to the auto industry, and Buick built P & W engines. Then Pratt & Whitney engineers took two twin *Wasp* engines: one built in the P & W plant, and one by Buick, each completely assembled where it was built, but neither having received the "green test." The engines were torn down, inspected, and then parts of the two were interchanged.

Crankshafts and crankcases were interchanged; gears from one plant mated those from the other; Buick cylinders were assembled on P & W crankcases; pistons from one engine went into cylinders from the other.

The two engines were then assembled with no special hand fitting and run through the normal green test. Upon being torn down for a thorough inspection, both engines were found to be in completely normal condition.

Funds Voted for 500,000 Tons of Carriers Work on Some Battleships is Suspended

Washington (AVIATION Bureau)—A trend that started in the minds of some militarists two decades ago when a battleship was sunk experimentally by American bombers, came near its climax the other day as Congress prepared to appropriate a fund of $8,500,000,000 for 500,000 tons of airplane carriers for the Navy. This tonnage might divide into 15 or 20 ships.

At the same time, Carl Vinson, chairman of House Naval Affairs Committee, stated that work has been "temporarily" suspended on four or five battleships. The bill makes no provision for any additional battleships. Presumably the 60,000-tonners, reported to be in process of design during the last year or two, are held in abeyance. Vinson said the carrier has been proved the "backbone" of the fleet. But he said battleships have not been abandoned, and that those nearing completion will be launched and completed.

Some officials said that a number of our heavy cruisers under construction would be converted to carriers.

Devastating air attacks by the United Nations on the Japanese and Italian navies are bringing new conclusions on the question of air power.

Airline Cargo Planes Flying Ten Hours Daily

About one million pounds of priority air cargo is being flown each week by the Contract Air Cargo Division of the Air Force, using facilities of 15 commercial airlines to deliver airplane parts, equipment and replacements throughout the western hemisphere, the War Department announces.

Maj.-Gen. H. J. F. Miller, commanding the Air Service Command, says that about 100 cargo planes being operated in the airline program, are being flown an average of ten hours and 1,500 miles a day, carrying about 3,500 pounds of cargo as well as personnel.

Stone Bros. Organize New Propeller Company

The Stone brothers of Wichita, Kan., long associated with the aircraft propeller industry and former operators of the Supreme Propeller Company of Wichita, have organized a new company to be known as Stone Brothers Propeller Co. They will begin immediate production of wood propellers, test clubs and blades for war needs. Officers of the new company are Wm. B. Stone, pres., Sam J. Stone, vice-pres. and gen. mgr., and Harry S. Stone, supt. of construction.

Glider Snatcher

A system for picking up gliders by tow planes while in flight has been devised and proved satisfactory at Wright Field. Gliders can be taken in tow by one plane at the rate of one every three minutes. A Stinson light plane and an XTG-3 glider were used in the test, the pick-up operating somewhat like the device used for catching air mail at small stations. The tow-line is placed across two uprights; the plane lowers its pick-up arm as it nears the "goal posts." A hook secures the line, and a reel in the plane pays it out, gradually tightening so that the shock is never greater than 1 G. When finally the reel is locked the glider is in the air.

Applications Suspended

No more applications for commissions in Air Force non-flying administrative posts are being accepted for the time being. The number of applications on hand meets the present requirement. The suspension does not affect men who have already filed applications, and it does not affect the flying cadet program.

"O'er the Land of the Free And the Home of the Brave."

AS THE AMERICAN FLAG leads new fighting forces to battle fronts throughout the world, it becomes more and more a symbol of complete unity on the production front as is evidenced by the fact that it is being displayed more and more in plants engaged in production vital to the war effort.

To help insure proper display of the Stars and Stripes by members of this new production army, there are presented herewith regulations prepared by the War Department, together with the Flag Code adopted by the Second National Flag Conference.

The War Department's regulations include the following points:

1. Civilians, as well as soldiers, should salute when the Flag is being raised or lowered or when it passes (uncased) in a parade.

2. A man not in uniform salutes by removing his hat with his right hand and placing it over his heart while standing upright with heels together.

3. A woman in civilian attire places her right hand over her heart, while standing upright.

4. Whenever the *Star Spangled Banner* is played, a civilian stands upright and faces the music, with right hand over heart, except when the flag is being lowered at sunset, on which occasion he faces the Flag and salutes as described above. The salute is held until the last note of the anthem is played.

The Flag Code, covering proper display of the Flag, is as follows:

1. The Flag should be displayed from sunrise to sunset. It should be hoisted briskly, but should be lowered slowly and ceremoniously The Flag should be displayed on all National and State holidays and on historic and special occasions.

2. When carried in a procession with other flag or flags, the Flag of the United States of America should be either on the marching right—i.e., the Flag's own right—or when there is a line of other flags, the Flag of the United States of America may be in front of the center of that line.

3. When displayed with another flag against a wall from crossed staffs, the Flag of the United States of America should be on the right, the Flag's own right (the observer's left), and its staff should be in front of the staff of the other flag.

4. When a number of flags of states or cities or pennants of societies are grouped and displayed from staffs with the Flag of the United States of America, the latter should be at the center or at the highest point of the group.

5. When flags of states or cities or pennants of societies are flown on the same halyard with the Flag of the United States of America, the latter should always be at the peak. When flown from adjacent masts, the Flag of the United States of America should be hoisted first and lowered last. No such flag or pennant flown in the former position should be placed above or in the latter position to the right of the Flag of the United States of America; i.e., to the observer's left.

6. When flags of two or more nations are displayed, they should be flown from separate masts at the same height and the flags should be of approximately equal size. International usage forbids the display of the flag of one nation above that of another nation in time of peace.

7. When the Flag is displayed from a staff projecting horizontally or at an angle from the window sill, balcony or front of building, the union of the Flag should go clear to the peak unless the Flag is at half-mast. (When the Flag is suspended over a sidewalk from a rope extending from a house to a pole at the edge of the sidewalk, the Flag should be hoisted out from the building toward the pole, union first).

8. When the Flag is displayed in a manner other than by being flown from a mast, it should be displayed flat, whether indoors or out. When displayed either horizontally or vertically against a wall, the union should be uppermost and to the Flag's own right; i.e., to the observer's left. When displayed in a window it should be displayed the same way; that is, with the union or blue field to the left of the observer in the street. When festoons, rosettes, or drapings are desired, bunting of blue, white, and red should be used, but never the Flag.

9. When displayed over the middle of the street, the Flag should be suspended vertically with the union to the north in an east-and-west street or to the east in a north-and-south street.

10. When used on a speaker's platform, the Flag, if displayed flat, should be displayed above and behind the speaker. If flown from a staff it should be in the position of honor, at the speaker's right. It should never be used to cover the speaker's desk nor to drape over the front of the platform, but bunting may be used for this purpose, if desired.

11. When used in connection with the unveiling of a statute or monument, the Flag should form a distinctive feature during the ceremony, but the Flag itself should never be used as the covering.

12. When flown at half-mast the Flag should be hoisted to the peak for an instant and then lowered to the half-mast position; but before lowering the Flag for the day it should be raised again to the peak. By half-mast is meant hauling down the Flag to one-half the distance between the top and bottom of the mast. (On a pole, the Flag flies its own width below the peak.)

13. Flags flown from fixed masts are placed at half-mast to indicate mourning. When the Flag is displayed on a small stall, as when carried in a parade, mourning is indicated by attaching two streamers of black crepe to the spearhead, allowing the streamers to fall naturally. Crepe is used on the flagstaff only by special order.

14. When used to cover a casket, the Flag should be placed so that the union is at the head and over the left shoulder. The Flag should not be lowered into the grave nor allowed to touch the ground. The casket should be carried foot first.

15. When the Flag is displayed in the body of the church, it should be from a staff placed in the position of honor at the congregation's right as they face the clergyman. The service flag, the state flag, or other flag should be at the left of the congregation. If in the chancel or on the platform the Flag of the United States of America should be placed at the clergyman's right as he faces the congregation and the other flags at his left.

16. When the Flag is in such a condition that it is no longer a fitting emblem for display, it should not be cast aside or used in any way that might be viewed as disrespectful to the national colors, but should be destroyed as a whole privately, preferably by burning or by some other method in harmony with the reverence and respect we owe to the emblem representing our country

WPB Announces Air Appointments

Dr. A. E. Lombard, Jr., is appointed administrator of the Aircraft Scheduling Unit, War Production Board, Dayton, Ohio. Col. E. M. Powers has been appointed by the Air Force, and Capt. Donald R. Royce by Navy Bureau of Aeronautics, to represent their services on the unit.

Col. W. S. Cave will continue to represent the British Air Mission. These appointments are made to handle the increasing burden of scheduling raw materials and machine tools to the aircraft industry.

Harold Talbott, long-time aviation financier and executive, has been appointed deputy chief of WPB's Production Division under W. H. Harrison, in charge of aviation. This means that the Aircraft Branch reports to Talbott, but Merrill C. Meigs remains chief of the Branch.

War Cancels NMACC

For the first time in over ten years, there will be no National Model Airplane Championship Contest. The 15th annual national airplane model flying competition was scheduled for Chicago the latter part of this month under the joint sponsorship of the Chicago Park District, the recreation department for the city of Chicago, and the *Chicago Times*.

CAA Gets New Boss

Nominated by President Roosevelt, Charles I. Stanton, Deputy Civil Aeronautics Administrator, is appointed administrator, to succeed Gen. Donald Connolly.

Born in Medford, Mass., in 1893, and educated at Tufts College, Mr. Stanton learned to fly at Kelly Field in 1917-18 and served as second lieutenant with the 122nd Aero Squadron. In 1918 he entered the employ of the Air Mail Service, Post Office Department, as test pilot. He left the aviation field in 1924 to join the U. S. Engineer Corps, and returned in 1927 as airplane and engine inspector in the newly-established Aeronautics Branch of Commerce.

Because of his engineering experience, he was transferred to the Airways Division as airways extension superintendent, and subsequently advanced to assistant to chief engineer, chief airways engineer, chief of the Airways Engineering Division, director of the Bureau of Federal Airways, deputy administrator, acting administrator, and now administrator.

Navy Changes Seen

Reorganization of the Navy Department, creating six new agencies to be headed by five vice-admirals and probably a lieutenant general of the Marine Corps, was anticipated by *Army and Navy Journal* at this writing.

One of the new agencies already set up, the Assistant Chief of Naval Operations for Air, is headed by Rear Admiral John H. Towers, who has direct control of the Naval Air Transport Service. Reorganization will set up five other agencies to be known as Assistant Chiefs of Naval Operations for Personnel, Materiel, Coast Guard, Marine Corps and Services. The changes are expected to bring emphasis on naval aviation, with greater stress on Navy's aircraft carrier construction program.

Though a highly centralized command is established, administratively, Navy will be divided into six main agencies, regarded as a greater consolidation of the administrative functions.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Before very long you will hear some proposals on wartime air mail. The priorities are on passengers and material while the mail has no rating. But each DC-3 trip, even if it carries 21 passengers, and their luggage, has capacity for about 1,500 lb. of cargo. Seldom would there be that much military material. Therefore, some mail will always go. War, Post Office and CAB officials are thinking it over. So plastic has the public become on patriotic appeals, it is feared they might over compensate if asked to curtail their air mailing, and leave space empty. One plan favored by some is to call for light-weight stationery. This would cut the load over half. Flimsy paper runs letters per pound from 24 to about 60. Heavy-paper mail could be shifted to the trains. Important heavy stuff, like war blueprint, could be posted with special stamps.

On the tail of Nazi submarines along our Atlantic coast are destroyers, torpedo boats, torpedo planes, bomb and gun carrying blimps, and bomb and cannon carrying patrol planes, to say nothing of Civil Air Patrol watchers with 20-20 eyes. Army and Navy believe the water will get too hot for the steel fish before very long.

Come to Washington—and wish you hadn't. You can't get a taxi. You can't get on the street car without a shoe horn. You can't get a telephone number without waiting maybe a half hour for it to un-busy. Tired middle-aged men with aching dogs sit late in hotel lobbies waiting for rooms. The temperature is even higher than the humidity. You can't "relax" because the night-spots won't give you a table. You are not "beckoned" here by the tourist bureaus. You are not welcomed by the Capital of the United Nations. But come on over if you must, and we mean *must*. If we can take it, so can you.

Did you see the Boeing ads, with the fine print at the bottom that says Flying Fortress is a word that belongs to Boeing? That word now has great value, because of something intangible called "public acceptance,"—and fear—all over the world. Well, some people, somewhere among us United Nations, wanted to call their airplanes Flying Fortresses. The lights went out! Sound of scuffling, stabs, groans! The lights came on—those people were gone.

Pressurizing bombers is going forward in Germany, according to a trustworthy authority. It's a continuation of the battle for altitude in air war. Probably the low-level atmosphere is carried in the crew quarters only, which would also house many of the instruments. The necessary oxygen equipment for the crew impedes their activities too much, and the pressure cabin will give them more freedom. It is thought possible the engines and the cabin might take their air from the same superchargers. Of course if pressure compartments were ruptured by attack, the crew would be in a serious way, and that is the greatest difficulty. Pressurizing war planes is one of the major development projects at this time. Pressure for fighters is in the works too. All warring nations are sweating on this job.

The British say: Canadian aircraft production this year is limited to seven types. . . . British pilots have flown nearly all types of Russian warplanes. . . . The Brown Boveri supercharger for the Rolls *Merlin* engine weighs 40 kg. for each cylinder bank, produces sea level pressure at 7,000 m., running at 24,000 r.p.m. Ministry of Aircraft Production has plenty of aluminum and light alloy. . . . Rolls Royce-powered Curtiss P-40-F is called the *Warhawk*.

War Department Calls For Glider Pilots

The Air Forces glider pilot training program is revised to include 27 instruction centers, the War Department announced. Primary work will be four weeks instruction in basic gliding principles at CPT schools, with nine Army schools for elementary and advanced courses. The latter will take two weeks of instruction in two-place and cargo-type glider piloting. Eligible are those who pass the Army mental and physical examination, CPT grads, holders of CAA private pilots certificates, former aviation cadets with 50 hr. in Army or Navy type training planes, and applicants who can submit proof of at least 200 glider flights. Age limit is 18 to 36.

The CAA administrator called for volunteers to train as glider pilots following a War Department request to find volunteers among graduates of the CAA pilot training course.

Press Association, Inc.

MILITARY GLIDERS

Charles I. Stanton, who conceived the idea of converting light training planes to gliders looks over the controls of a new three-place training glider with Capt. Donald Hamilton (left) in charge of glider training, Flying Training Command, and Maj. Lewin Barringer who piloted a glider in a demonstration over Washington National Airport.

800 CAP Commands

With total enlistments of 48,000, the Civil Air Patrol has organized more than 800 unit commands throughout the country. Additional squadrons are being formed. Under the 48 State Wing Commands, there are 287 Group Commands. Under the groups are 476 squadrons, each composed of 50 to 200 members.

Final arrangements have been made for master policies covering accident, crash, and liability insurance for all active-duty missions of the patrol. This coverage will be compulsory for all missions performed at the request of and with funds supplied by federal and state governments or subdivisions thereof.

Patrols covering coasts, forests, pipe lines and courier and miscellaneous services for defense agencies are included.

This type of insurance is not compulsory, however, for practice missions which the CAP is conducting on an increasing scale throughout the country.

CALLING NAMES

Herbert V. Shebat is named acting senior air safety investigator at the CAB Safety Bureau in Chicago.

George P. Baker is detailed in the Office of the Quartermaster General, War Department.

John A. Collins, is elected vice-president in charge of operations for TWA. **Clarence Fleming** is appointed a vice-president; also holds position of assistant secretary.

Allan S. Lehman is elected a director of the Studebaker Corporation. Since 1908 he has been a partner of Lehman Brothers.

Gill Robb Wilson is elected to the board of trustees of Washington and Jefferson College at Washington, Pa.

Charles A. Smoot is appointed assistant to the president of Continental Air Lines; **Ray Johnson** is appointed assistant superintendent of maintenance.

Samuel F. Pryor, Evan E. Young, and **Harold M. Bixby,** all vice-presidents of PAA, were elected to the board of directors, filling all existing vacancies.

Arthur F. Kimbell recently was named president of United-Carr Fastener Corp.

James K. Fulks has been elected vice-pres. in charge of mfg., for Ex-Cell-O Corp.

J. M. Barr relinquishes duties as United Aircraft factory mgr. to give full time to his new position as asst. gen. mgr. **B. T. Taliaferro** becomes factory mgr., **John F. Hemmert** goes up to asst. factory mgr.; **Sydney Hexson** becomes factory supt and **Earle F. Ray** his assistant.

R. Stanley Webber, Delta Air Lines public relations director, is named asst. to the gen. mgr. and will supervise traffic dept. during absence of **Leigh C. Parker,** now on active duty with the AAF.

Two more UAL executives join the Ferry Command: **Edmund Schroeder,** mechanical operations supt., has become a major with the Ferry Command and **B. C. Voight,** formerly mgr. of the eastern division passenger service, a captain. He is succeeded by **Max D. Kelley,** former chief mechanic at New York.

Henry E. Kingman has been elected exec. vice-pres. and a director of Solar Aircraft Co. and **Ray E. Craig** has been named comptroller. New directors include **Herbert F. Sturdy** and **Ralph E. Rollins.**

Edward G. Haven is named sales mgr. of the aviation division of GE's Industrial Div. and **David R. Shoults** becomes engineer for the same department.

Edward Noe has been appointed secretary of The Sheffield Corp. and **John P. Bernard,** vice-pres. and gen. mgr., has been elected a director.

A. F. Boucher, Detroit district mgr. for Lincoln Electric, has been called to active duty, attached to the Ordnance Dept.

George Kentis, Jr., has been promoted to chief engr. of the Yoder Co, Cleveland.

Charles L. Nielson has been appointed controller of Fleetwings, Inc.

Copperweld Steel Co. appoints **F. B. Davis** as sales mgr. for the Buffalo district.

John W. Rockefeller, Jr., has been appointed sales engr. in New York and New Jersey areas for Instrument Specialties Co.

George Montague Williams, Vultee vice-pres. and chairman and pres. of Russell Mfg. Co., has also been elected chairman of the board of American Central Manufacturing Corp.

UAL's asst. publicity director **Edmond S. Fish,** has been loaned to the Greater New York Bond Pledge Campaign as coordinator of special events.

John S. Gulledge, St. Louis district mgr. of Goodrich Industrial Products Division has resigned to enter the AAF and has been succeeded by **George Livermore.**

Entering the glider manufacturing field as vice-pres. of Bowlus Sailplanes, Inc., is **Norman Larson,** an owner of Pacific Aircraft Sales Corp.

Harkness W. Cram, sales mgr. of Aircraft Screw Products Co. has been named vice-pres. in charge of sales.

Jack Wiseman goes to Washington as special representative of Ryan Aeronautical Co. where his activities will be closely coordinated with those of **Sam C. Breder,** Ryan sales mgr.

George Harrison becomes terminal mgr. for NWA at Portland, Ore., succeeding **Frank Taylor,** who takes over a similar position in Seattle.

New exec. vice-pres. of Borg-Warner is **G. A. Shallberg,** who has been general counsel of the company since its inception and a vice-pres. since 1939.

Lord Mfg. Co. has announced appointments of **Cameron Duncan** as sales representative for the West Coast area, and **G. D. Obenhaur** in charge of sales engineering work in the Detroit area.

John Purcell has been appointed director of public relations of Carl L. Norden, Inc.

Wayne A. McGowan, formerly with Consolidated Aircraft, is now a civilian aeronautical engineer at the Naval Air Station, Alameda, Calif.

Mosher S. Hutchins, president of Hutchins Advertising Co., Rochester, N. Y., has been appointed captain in the AAF. Meanwhile, his business duties are being assumed by **F. Irving** and **Frank A. Hutchins.**

Edward W. Ainsmith has joined the staff of Republic Aviation as athletic director.

The Udylite Corporation has moved from 60 E. 42nd St. to 11-16 44th Drive, Long Island City, N. Y.

Jack Zimmerman is the subject of "Million Miler," John R. Tunis's new book.

All twelve directors of UAL were re-elected at the annual meeting in Chicago. Directors are **Ansorge, Ripley, Governor Sewall, Fuller, Dart, Armour, Cresap, Patterson, Mitchell, Herlihy, Godehn** and **Roloson.**

Lt.-Comdr. Harvey Harman, Naval Reserve, will head the competitive sports program at the University of NC pre-flight school for aviation cadets.

A. W. French is appointed assistant mail and express traffic manager of TWA at Chicago. **S. E. Russ, W. H. Pluchet** and **R. M. Payne** head the Eastern Central and Western regions.

Eugene W. Norris, of the Aircraft Engineering Division of CAA has joined the staff of the technical department of the Aeronautical Chamber of Commerce for full time work on National Aircraft Standards Committee activities.

R. V. Carleton has been appointed chief pilot of Braniff, succeeding **R. W. Pears,** who has resigned to accept an assignment with the AAF.

Allen R. (Bert) Seaton has joined the Speedwall Co., division of I. F. Laucks, Inc., as head of wooden aircraft parts production.

Justin A. Fitz of Sperry Gyroscope Co. is president of the Aero Club of New York—the New York chapter of NAA—succeeding John B. Walker of United Air Lines.

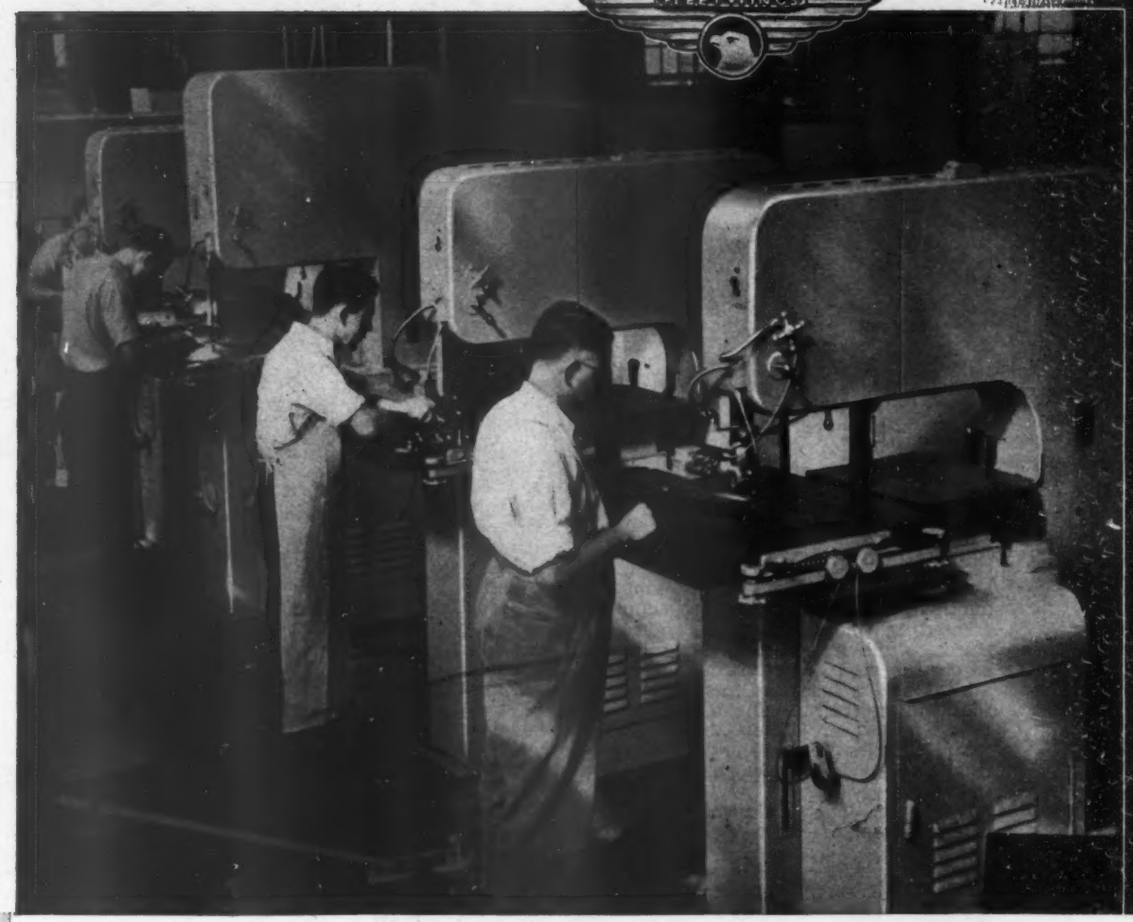
Charles F. Nielson, for the past six years Lockheed and Vega traffic manager, has been appointed director of traffic and transportation for the Army Air Forces with headquarters in Washington.

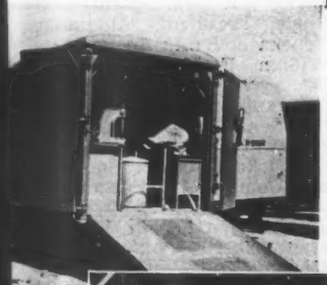
DoAll AT FLEETWINGS

This battery of DoAlls is important part of the ight-line-flow production stem which has simplified ch worker's job and in- eased output in the Fleet- ings plant.

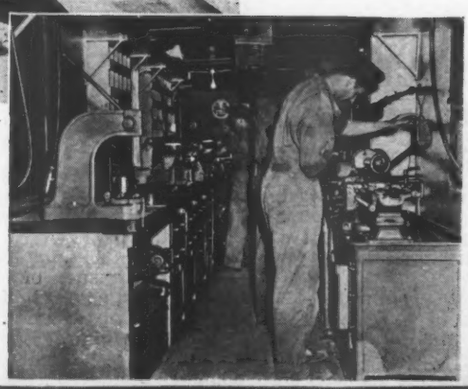
the home of the world's st warplane built almost olly of stainless steel, th 450 "horses" under her eamlined engine cowling.

re 15 stainless steel ribs formed at one time. An dless chain of sub contract ders for fuel tanks, ammu- ion, chutes, turret rings, vators, fins, stabilizers, ders, etc. is coming off line day and night. Pro- ction has been tripled.





★ AIRPLANE AMBULANCES ★



WIZARD OF MACHINE TOOLS

Designers and manufacturers of planes and parts are alert to the versatility of the time-saving DoAll, which offers the fastest precision method of internal and external sawing of stainless steel, aluminum, magnesium, copper, synthane, masonite, plymetal, etc. There are 42 DoAll saw bands, a "right" one for every metal and alloy.

Investigate the DoAll at once for war-time and peace-time uses.

NEW BOOK—"DoAll on Production", a record of unusual jobs done with the DoAll. An interesting story told in pictures. Send for copy today.

THE EXACT SIZE FOR YOUR JOB

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All Models with Motors

THE "DoAll" USES 3 KINDS OF BANDS

SAW BANDS 1/8" TO 1" WIDE 48 STYLES — FILE BANDS 1/4", 3/8", 1/2" WIDE 23 STYLES — POLISHING BANDS 1" WIDE

CONTINENTAL MACHINES, INC.

600 SOUTH WASHINGTON AVE. — MINNEAPOLIS, MINNESOTA

Patterson Says We'll Exceed 60,000 Planes Over 30 New Airplane Factories Building "U. S. Will Surpass Rest of World," Jouett

Washington (AVIATION Bureau)—We will pass the President's goal of 60,000 planes in 1942 "by a substantial margin," in the opinion of Undersecretary of War Patterson.

Military plane output has increased nearly 85 percent in the six months since Dec. 7, says Col. John H. Jouett, president of the Aero Chamber of Commerce. The percentage of combat planes is increasing while the proportion of trainers is smaller. Aircraft engine production has increased 80 percent during the six months, partly due to participation of the auto industry.

The Aeronautical Chamber of Commerce states that on April 1 the aircraft industry's unfilled orders exceeded December by over 75 percent. During the same period, production of military planes increased by more than two-thirds, while the number of employees on planes, engines and propellers increased more than 30 percent. During the period more than 30 new aircraft factories were either in final plan stage or under construction.

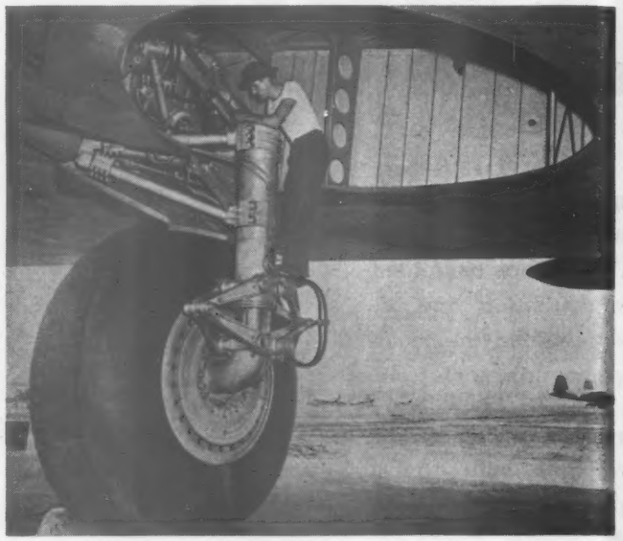
Col. John Jouett said that when these plants begin turning out planes United States production will "easily surpass that of the rest of the world combined."

WPB officials say that for several months the United States has been producing more planes than Germany and Italy. Correspondents returning from Europe have been giving surprisingly low estimates of Axis production. J. Carlton Ward, Fairchild president, gives the highest figures AVIATION has seen lately: Germany and territory, 2,900 per month; Italy, 700; Japan, 500.

Meanwhile, to speed production, WPB, Army and Navy, and the Aero Chamber are working out a plan to end materials shortages. Manufacturers will advise WPB of their materials needs far enough in advance so that supplies may be set aside. The aircraft industry is leading others in long-range operations under WPB's Production Requirements Plan (PRP).

Aircraft producers are training 40 automobile companies in the mass production of plane parts and engines. The program was started two years ago, and cooperation is reported to be excellent.

Earl D. Osborn, president of Edo Aircraft Corp., presents Capt. N. B. Farwell, USN, with a check for $9,072, representing the wages earned by Edo employees on a day which they donated to the Navy. Also presented were three seaplane floats which were produced on the payless work day.



International News

MAN AND A GIANT

Size of the Army's B-19 "flying laboratory" can be judged by comparison with the mechanic shown tinkering with the landing gear mechanism. The plane was first exhibited in full war paint at Wright Field recently.

Navy Will Use a Liquid-cooled Engine

The Navy has ordered liquid-cooled engines from the Liquid Cooled Engine Division of The Aviation Corporation. Navy's last liquid - cooled - powered plane was the Hall PH-1 flying boat, dating back to 1930.

Navy says its new engine, which has been under development with Lycoming for several years, is "considerably larger than any other liquid-cooled aircraft engine now in production." The announcement implies it is comparable in performance with the largest aircooled engine, which would be around 2,000 hp.

Undoubtedly the Navy wants the liquid-cooled engine, with its smaller frontal area, to power small fighter craft.

Construction of a new plant in Ohio to produce the engines has been started.

Navy Returns Brewster To Private Management

Plants of the Brewster Aeronautical Corporation have been returned to the owners.

The executive direction has been placed in the hands of a new board of directors, although several of the former officers were retained. The new president and chief executive of the corporation is C. A. Van Dusen, vice-president and general manager for the Glenn L. Martin Company for several years up until 1934, and from then until the end of 1941, first vice-president in charge of production for the Consolidated Aircraft Corp.

George F. Chapline, former vice-pres., becomes executive vice-pres.; John R. Hunt retains the position of secretary but is no longer treasurer, a position assumed by Russell Van Horn; Carl S. Goodwin becomes comptroller; Miss Elizabeth Colby, assistant secretary and L. F. Lafleur, assistant treasurer.

The board of directors includes Mr. Van Dusen; E. J. Engle, president, Atchinson, Topeka & Santa Fe Railway; William F. Kurtz, president, Pennsylvania Company for Insurances; Evan Randolph, president, Philadelphia National Bank; F. Dean Schnacke of Smith, Schnacke and Compton, who also serves as general counsel; David Van Alstyne, partner in Van Alstyne, Noel & Co.; and Capt. George C. Westerfelt, who was in charge of the plant for the government.

Wood and Steel Increase in Trainers

Washington (AVIATION Bureau)—Army is increasing emphasis on substitute materials in training planes.

Even the fuel tank of one trainer is made of wood. Aluminum has been eliminated entirely from another, and many types are reducing aluminum by hundreds of pounds.

Woodworking and furniture plants are subcontracting trainer parts on a large scale.

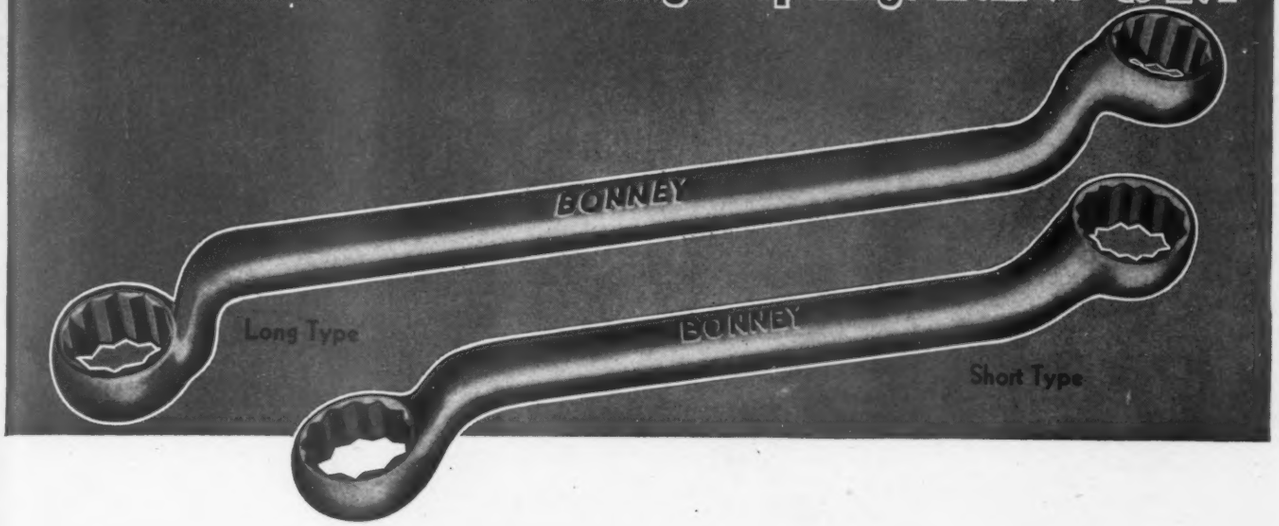
The Finest that Money Can Buy

BONNEY TOOLS

BONALOY BOX WRENCHES

Both Ends Offset—A Different Size Opening Each End

35 Combinations of Double Hexagon Openings from 3/8" to 2 3/4"



Bonaloy Box Wrenches with both ends offset and a different size double hexagon opening in each end meet practically every production, maintenance and service requirement for tools of this type.

They are made in long and short types with 35 different combinations of openings from 3/8" to 2 3/4".

Drop forged from Bonaloy Steel carefully heat treated, they have rust-resistant finish. Handles are long, thin and oval-shaped affording a firm, comfortable grip. Box walls are thin, but of exceptional strength, permitting work in cramped quarters.

Proper design, quality materials and fine workmanship make Bonaloy Box Wrenches "the finest that money can buy." We will be glad to send you catalog giving the complete list of sizes and showing the full line of Bonney Tools.

BONNEY FORGE & TOOL WORKS, Allentown, Pa.

In Canada—Gray-Bonney Tool Co., Ltd., Toronto

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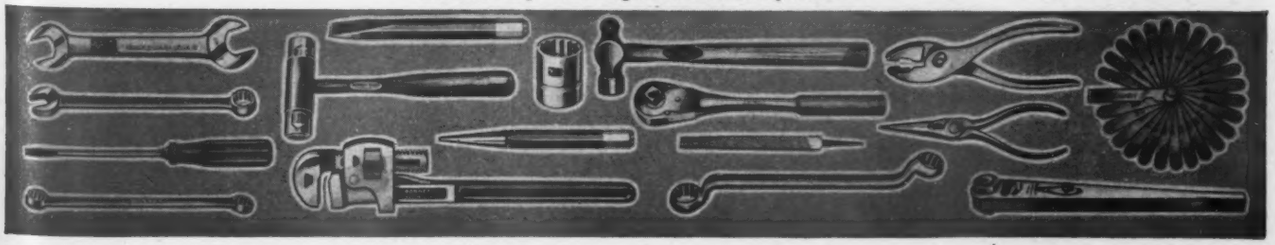
Stocked by Leading Jobbers Everywhere



Continental Powered Boeing Trainers
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MUSKEGON, MICHIGAN

Beech, Fairchild and Boeing AT-10, 13 and 15 respectively, all two-engine planes, are to be almost entirely of wood. Wooden fuel tanks are lined with synthetics. North American's AT-6A is being built of low carbon steel and wood, eliminating 75 percent of aluminum.

Vultee's BT-15 has been redesigned to eliminate aluminum, making the change without interrupting production, and the earlier BT-13 is being studied for steel and wood construction.

Ryan's PT-22 only all-metal trainer, has been stopped and the plant converted to subcontracting; Ryan's PT-21, Boeing's PT-17 and Fairchild's PT-19—all are combinations of wood, steel and fabric, with small amounts of aluminum in some.

Substitution is being carried into combat planes too, at points where it doesn't impair strength.

From Refrigerators To Excaliburs

Before the war, Nash-Kelvinator manufactured automobiles and household appliances. Today it's turning out planes and parts for the services. The first contract was to build Hamilton Standard hydromatic, variable-pitch propellers. A deserted automobile plant in the Mid West was redesigned and equipped by Nash-Kelvinator. In seven months the plant was producing propellers. Another contract came their way and another plant in the same town was redesigned and equipped.

Next they started making parts for the automatic plane pilot used in bombing planes. Following that, came a contract for Pratt & Whitney air-cooled engines. This led to an assignment to build a complete plane for the Navy—an almost exact duplicate of the *Excalibur*, which was recently completed by Vought-Sikorsky for trans-oceanic commercial service.

ALCOA Cuts Prices

Substantial reductions, beginning June 15, in the prices of fabricated aluminum products have been made by ALCOA, OPA announced.

Savings will be made to the government in purchases of planes and other war materials using aluminum. Reductions range from over 20c. per pound down to 1c. a pound.

McOuat Named Romec Head

Ralph H. McOuat (left), former vice-president of Pump Engineering Service Corp., has been elected president of the Romec Pump Co., Elyria, Ohio, and Carl F. Shuler (right), former law director of Cleveland, is the new treasurer. McOuat succeeds W. H. Hill in the Romec presidency. Other directors are Henry D. Stecher, Frank H. Grace, Harry L. Cassman and A. B. Taylor. The Romec Co. produces non-pulsating fuel pumps, instrument, de-icer and hydraulic pumps. Opening of a new and larger plant was recently announced.

ASSEMBLY LINES . . . By Dorsey Adams

Drastic restrictions on the delivery and use of mahogany and Philippine mahogany suitable for construction of military aircraft and combat vessels are imposed by the WPB. The order was necessitated by shortage of transportation facilities for mahogany from foreign sources to the United States. Imports from Central America will be restricted in the future to those grades of mahogany suitable only for military and naval purposes. The order prohibits sale or delivery of "war-use" mahogany or "war-use" Philippine mahogany except on orders from the U. S. government or Lend-Lease.

In a government-built plant in Oklahoma, the Douglas Aircraft Co. has begun operations, and has completed plans for additional plants in another part of the state and in the Great Lakes industrial region. Of the total backlog, more than 90 percent is on a fixed-fee basis. Approximately three-quarters of the company's 1942 business will be fixed-fee, one-quarter being on fixed-price contract which remain to be completed in the year. Much of the backlog calls for a 6 percent fee, recent contracts voluntarily have been reduced to 5 percent before taxes.

The men who built the engines that carried 79 American fliers on the great Tokio bombing raid were praised by the man who led the flight, Brig.-Gen. James H. Doolittle. In a telegram addressed to the employees of the Wright Aeronautical Corp., Gen. Doolittle expressed appreciation for the part that employees had played in the raid. Bombers were North American B-25's, powered by two Wright Cyclone 14-cylinder engines of 1700 hp. each.

Sub - Arctic temperatures, which grounded Hitler's air forces in Russia, have made United States airplane industry low-temperature conscious, says T. N. Floyd, altitude engineer of Douglas cold-room laboratories. More than 30 manufacturers of airplane parts and accessories are operating cold laboratories. Engineers had discovered and largely overcome the effects of sub-zero cold on hydraulic lines, rubber connections and functional parts requiring lubrication. The effectiveness of airplanes decreased in direct proportion to the amount of modern equipment on them. In temperatures of —50° F., and under, the German planes would not function. On the other hand, certain of the older types of Russian planes were able to take the air. This partly explains the sudden ascendancy of the Russion Air fleet over the German, and the destruction of numerous German planes on the ground.

First 30-ton Consolidated heavy bomber, the B-24-E, recently came off the production line at the Ford Willow Run plant. The announcement came 13½ months after the first work was done on the physical construction of the plant, which is said to be the world's largest manufacturing unit under one roof. The building, which was erected in record time, is well over half a mile long, with practically all working space on one level. In addition, there are hangars adjacent to a seven-runway field from which fly-away deliveries will soon be made in growing numbers.

Powered assembly lines are well under way at Republic Aviation Corp. At least a part of the system, expediting production by reducing handling time, will be in operation within 30 days. A drag-chain hole, approximately 7x4 in., extending through the final assembly plant, has been dug. Two large holes, one to house the power unit and the other to take up the chain slack, have been excavated at each end of the chain hole. Equipment will be put in place as rapidly as delivery and other factors permit, and will be accomplished without interfering with the routine now followed. Under the old system, ships were placed on stands, and pushed by hand to the next station. Installation processes never could be timed accurately; nor was it possible to establish a satisfactory pace. Analyses showed that ships could be assembled in pre-determined order, with a minimum of space being utilized. The object is to have as many men working as possible, without getting in each other's way. By outlining the sequence of parts and timing the assembly, production allotments can be made to various stations, so that each unit works in complete time cooperation with all other groups. Each line has variable speed control.

A streamlined production technique is in effect at Cessna. In addition to lowering costs and permitting a substantial reduction to be passed on to the government, speedy deliveries made possible by the new system resulted in new contracts for Cessna *Bobcats* and *Cranes*. These and other war contracts have necessitated the establishment of a sizable branch plant in Kansas expected to be in production shortly. Cessna's plans for the production of the Cessna "family car of the air" are being held in readiness for the day of victory.

When Ford bombers leave the assembly lines at the Willow Run plant, they are powered by Buick-built Pratt & Whitney type engines. No indication of output has been made by either Buick or Ford. Buick recently announced it is a year ahead of production schedules and shipping engines in trainload lots to several plane manufacturers, including Ford. A leading West Coast aircraft manufacturer, lately reported exceptional performance tests on the Buick engines which exceeded the standards set and elated the test pilots.

Boeing and N. W. Ayer, its advertising agency, are starting to tell the story of the airplane in a series of ads to appear in magazines throughout North and South America. The purpose is to give people a first hand, close-up picture of aircraft design, engineering and production at its best. *Life, Saturday Evening Post, Collier's* and *National Geographic,* as well as to readers of weekly news and business magazines, *Time, Newsweek, Business Week, U. S. News,* and others, are on the schedule.

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CHEMICALS	GLASS	SYNTHETIC COATINGS
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News Notes From Britain

LONDON (*Special Correspondence*)—**A busy season has begun** on the London-Lisbon line which British Airways and the Dutch KLM maintain to connect with United States Transatlantic and British Empire services. From the start of regular services on this line after the French debacle in June, 1940, until the end of March, 1942—over more than 21 months—8,391 passengers and 722 tons of cargo were carried between England and Portugal without injury or loss, not counting traffic on British lines to destinations further south and east which call at Lisbon. The contact service for Atlantic flying boats has been eased, of course, by the resumption of traffic from and to Foynes in Ireland, but Lisbon retains its importance as Europe's western and southernmost civil airport.

From Continental Europe comes news of further curtailment of civil aviation. The Spanish "Iberia" lines had to cut their remaining services by half; shortage of gas is given as the reason. Swiss Air has been reduced to a single line—Zurich-Stuttgart-Berlin—and idle aircraft is occasionally used for children suffering from whooping cough; lack of fuel forced even flying schools to close down. In Italy planes retained on civil airlines must carry increased loads over longer mileages owing to withdrawals of aircraft "for other purposes;" of air services closed down last autumn only one has reopened this spring—Milan - Venice - Zagreb-Budapest—which links Italy with Croatia and Hungary. In France a regular service has been started between Vichy and Paris. Sweden again accepts air mail dispatches for the British Isles—an indication that the two countries are once more linked by a routine airline. Aer Lingus Teoronta, Eire's aviation company, reported higher figures for 1941—10,270 (7,528) passengers, 39,555 (34,855) lb. freight, 209,372 (173,896) mi. flown—but handles only half the passenger traffic it could carry; the difficulty is to get aircraft.

Women are no longer outsiders in British aviation. Women pilots are employed to taxi aircraft from factories to airports, and women infiltrate slowly and steadily all sections of the ground staff on civil airports. Trained draftswomen prepare detailed maps and charts setting out tracks, airport locations, radio stations, prohibited areas, etc. Others specialize in meteorological calculations and timetables giving sunrise and sunset at different longitudes, duration of twilight, averages of air speed and height, etc., to be used on individual flights. Transport drivers, traffic clerks, teleprinter operators and tracers are now largely women. Specialized jobs in British Airways' repair and overhaul shops have also been entrusted to women, with complete success where accuracy and conscientious workmanship are required.

British-Combine

RAF—EXPORT DEPARTMENT

Loading one of "those big beautiful bombs" into the racks of a "Manchester" super bomber which is now making regular deliveries where it hurts the Axis the most.

ON SCHEDULE . . . by "Vista"

With war production getting ahead of available shipping space, which in turn is handicapped by the present U-boat campaign, it came like a very pleasant surprise that the government at last realized the immense possibilities of international airfreight.

It is perhaps a pity that the decision to establish a special air-cargo board, with such experts as Harold Talbot, T. P. Wright and Grover Loening, was only made after we had been in a war of vast distances for nearly six months, but much progress has already been made in the right direction and cargo by plane will soon be able to play its part. Budd will shortly get into mass production on stainless steel cargo planes, once mentioned for a vast over-all hemispheric commercial airnet, but now destined for a grimmer purpose. Together with the wooden Curtiss C-76, the Budd cargo carrier will be the first airplane designed for just that job. It is naturally not known just yet what the actual performance will be of these planes, but if they are only those of the popular DC-3, then the results will be farreaching.

It is generally felt that the decision to emphasize air-cargo was strongly influenced by the results obtained during the past six or seven months with the Pan American planes, which have been doing essential cargo work in the Pacific area, besides transporting more material than is generally known over the North Atlantic, to both Foynes and Lisbon. Over the South Atlantic, the cargo service has already reached a more prominent status with PAA's ferry line, which has been able to virtually establish and supply all of the bases set-up on the Dark Continent for the continuous stream of supplies and planes to the United Nations.

During this war there have been quite a few examples of the effectiveness of air freight, coupled perhaps with gliders—Crete was invaded and held in this manner; Norway was taken over in much the same way, and the present Axis Libyan Armies seem to be kept going by freighters crossing at night and landing on the desert. Before the war, air freight had reached vast proportions everywhere but in the United States, where more attention had been paid to passengers. In Central America, TACA was carrying over 20,000,000 lb. per year with converted passenger planes, including tractors and pieces weighing up to three or four tons. Canada, operating under conditions rather similar to our own domestic lines, but with extensions in the frozen north, was carrying a like amount on mostly regularly scheduled services. In Europe, one smallish airline carried nearly as much freight in one year as all the domestic airlines combined, and its performance was even surpassed, especially by the German DLH.

This whole move also indicates that converted airliners cannot work satisfactorily over routes which have been laid out for ferrying warplanes, and that equipment must be found which is specifically designed for the job. Cargo carrying gliders, with just one man at the controls, are being studied at the moment, since the feature of being able to land maybe ten tons of freight without endangering a heavily loaded prime transport on poor jungle airdomes, sounds most attractive. A system is even being worked out to pick these gliders up with a smaller slower plane, a la All American Aviation.

Finally, it must be gratifying indeed to the advocates of air-cargo, especially Grover Loening, that their pleas for international transportation of freight by air have been heeded at last, and that America will take its rightful place in this development.

In South America, Brazil turned over the confiscated Condor line to Argentina for operation, a move looked at askance because of the great number of Axis airline operators in that country.

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Canadian News

BY JAMES MONTAGNES

MONTREAL (Special to AVIATION)—Expansion of Canada's air cadet organization to a force of 50,000 teen-aged youths in the next year was forecast at Ottawa by Group Captain D. C. Hume, national director of the Air Cadet League of Canada on the League's first anniversary. The air cadets come under the direct control of the Royal Canadian Air Force, consist of high school boys 12 to 18 years of age. During the first year the air cadets developed 135 squadrons with 15,000 boys. There are 33 squadrons in Ontario, 32 in Quebec, 21 in Saskatchewan, 21 in Alberta, 14 in British Columbia, 7 in Nova Scotia, 4 in Manitoba, 2 in Prince Edward Island, and 1 in New Brunswick.

Trans-Canada Airlines Ltd., government-owned transcontinental airway, has six planes on order in the United States. When delivery is made a new service to Alaska will be instituted, according to H. J. Symington, president of TCA, before a Parliamentary Committee at Ottawa. The Alaska line is now operated by Yukon Southern Airways, a subsidiary of Canadian Pacific Air Lines.

Post-war plans of TCA, Mr. Symington told the committee, include operation of four-engine planes and the straightening of the Toronto-Winnipeg route by way of Sault Ste. Marie and Fort William. He urged continuance of the government policy of restricting private enterprise in Canadian airlines to branch lines not up to the standard of main line service, while admitting at the same time that these branch lines might eventually prove the most profitable field.

With the opening of a new service to Newfoundland, TCA has appointed C. E. Holton as traffic representative at St. John's, and G. M. Dempsey to succeed Holton at Windsor, Ont.

Nine of the ten civilian flying companies operating air observer schools in Canada for the Royal Canadian Air Force under the British Commonwealth Air Training Plan have voluntarily offered to run them on a non-profit basis, it was announced at Ottawa by C. G. Power, air minister. The offer is being accepted as a new basis of operation. The non-profit arrangement is apart from a five percent allowance on the capital investment of these companies, set at $50,000 each. The companies have also offered to return to the government all profits which accrued from their operations since the schools were started, and this offer has also been accepted. It was disclosed in Parliament that operating profits ranged from $19,654 over a 24 wk. period in one case to $64,330 for a 96 wk. period in another. Under the government contracts these schools were afforded opportunities to earn from 10 to 60 percent on their capitalization. Earnings and savings under the various contracts amounted to $356,400 at the end of May, 1942.

Schools which will return profits are those operated by Canadian Pacific Air Lines, Ltd., at Malton (Toronto), Edmonton, Winnipeg, Portage La Prairie, St. John's (Que.) and Ancienne Lorette (Que.); operated by Leavens Bros. at London, Ont.; by Prairie Airways at Regina; by Northumberland Flying Training Co. at Chatham, New Brunswick.

British-Combine

THE AMERICAN ACCENT

When the British aircraft carrier, "HMS Illustrious", put into a United States port for repairs after the mauling she got from enemy dive bombers, a number of American innovations were assigned to her. Among them was this baby tractor used for ranging aircraft, such as this Grumman "Martlet" fighter, on the deck.

Hints on Surface Finishing STAINLESS STEEL

1. Order Only That Finish Necessary.

Do not order a better finish on your stainless steel than is necessary. Why use power and tie up machines for a mirror finish if it will be subsequently marred by forming or fabricating operations.

2. Use Iron-Free Grit.

Use of an iron-free grit to grind or polish stainless steel makes subsequent passivation generally unnecessary. The abrasive should not have been used previously on any metal other than stainless steel.

3. Select Abrasive Wheels Carefully.

An abrasive wheel should be selected that does not load (clog) so much as to prevent cutting, but yet does not wear faster than necessary to offer a clean surface. Excessive loading of the wheel is apt to make the work tedious and to result in hardening of the stainless steel, while excessive wear is, of course, wasteful.

4. Use Light Pressure on Abrasive Wheel.

Easy does it. Too heavy a pressure with the abrasive wheel is wasteful of time, power, and grinding material because it hardens the stainless steel. The resulting overheating can cause heat-tinting and less uniform polishing.

5. Paper or Lacquer Will Protect the Surface.

When it is necessary to fabricate products from polished stainless steel, paste on some heavy paper or coat the metal with lacquer to protect the polished surface from damage during grinding of welds and during other fabrication processes.

• • •

We do not make steel of any kind, but throughout our 35 years as a producer of ferro-alloys and metals used in making steel, we have accumulated a fund of data on alloy steels. This information has often proved of great value to users of alloy steels and irons. The benefit of this experience is available to you, without obligation.

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Army Cuts Airline Routes and Schedules Sets Up Priorities on All U. S. Services Ray Ireland is Chief of "Air Division"

Washington (AVIATION Bureau)—Army did not "take over" the airlines as confused reports indicate. Airlines still are operating about 250 of their planes, of which about 70 are being converted to cargo carriers—which the airlines fly, for the Army. About 100 planes, balance of the previous total of around 350, were transferred outright to the Army.

In general, the plan retains the long-haul routes which really save time. Places which can be reached over night or in three hours by day on trains won't be flown.

Space preference goes to persons on hurry missions in the public interest, and to rush items of war material. After that comes the mail, any portion of which can be put on the trains. (See Washington Windsock, page 265.)

There is not yet any rule against riding the airlines; when there are seats you can have them—and welcome.

The War Department has appointed Ray W. Ireland, formerly traffic manager of United Air Lines, as chief of the Air Division of the Army's Transportation Service, which, with five other divisions: Rail, Water, Motor, Traffic Control and Transit Storage—come under the Army Services of Supply. It was expected at this writing that Ireland would be commissioned in a few days.

War Secretary Stimson said the Air Division's function would be to administer preferences for cargo and passengers on all scheduled airlines in the United States and on oversea routes and on the Ferry Command. Capt. Leigh Parker, of the Air Force, former vice-president of Delta Air Lines, is assistant to Ireland.

It was the short lines that got hit, but it was unavoidable. And the transcontinentals are losing their merry-go-rounds: Chicago-New York is cut from 33 to 20 round trips daily; New York-Boston from 25 to 9; Washington-New York, 52 to 16; San Francisco-Los Angeles, 13 to 8.

Meal service is out or down to coffee and cookies. Sleepers are out and equipment is converted to cargo. Round trip tickets and discounts are eliminated.

Meanwhile, Civil Aeronautics Board has more to do than ever. It has procedure for handling suspensions of schedules and point-to-point service; harmonizing war and civil traffic; recommendation of what is essential war travel; continuation of the automatic air mail rate system; liaison between airlines and Army on pilot training, air services command, repairs and overhaul; cooperation with the Military Director of Civil Aviation and with the Air Division of Army Transport.

Wide World

"MIAMI CALLING"

Anne Kathryn Porter is now a full-fledged radio operator for Eastern Air Lines at Miami. She started studying at 15 and became a licensed radio telephone operator at 19. When the war broke out she landed a job with the Army in the radio engineering department. After three months she took a job with Eastern Air Lines.

AIR CONTROL DESK

A new-design central control desk at PAA's landplane base at Miami incorporates many ideas of James F. Wynne, chief air controller of PAA's eastern division, shown here. One feature of the desk is volume control within arm's reach, enabling the operator to tune and survey the field at the same time.

PAA and AEA Start New York-Eire Service 5,000 Refugees Flown Out of Combat Zones

Pan American's New York-Foynes, Eire, service resumed in late May, having been abandoned in 1939 in accordance with the "neutrality" law. First trip, flown by Audrey Durst, reached Foynes with 20 passengers.

A London dispatch, on which officials have no comment, says American Export Airlines was starting New York-Eire service in June, with its Vought-Sikorsky boats. The company had two at this writing and was about to receive a third.

PAA now carries most of the transatlantic mail and majority of government and war officials. Since the war started mail loads have multiplied ten times; single loads have run as high as 13,620 lb. Routine overhaul of planes takes one-third the time it took before the war—six days to two days in hangar.

Mainline services have been increased 30 percent around the world. On the Pacific, 75 percent of pre-war scheduled mileage is being flown. On the Atlantic *Clippers* are logging twice the pre-war mileage. The company has undertaken many special missions for the government.

In the East, PAA-China lines flew 5,000 refugees out of combat zones; DC-3's carried as many as 400 in one night, bringing back war cargo. Sometimes 60 passengers were carried in 21-passenger planes. Military and civil services rescued 8,000 persons.

Rescue flights had to be made in weather so bad that Jap fighters couldn't *get* up to attack.

PAA censored releases reveal that its ships have been attacked more than once.

TCA Reservations

To give fast reservation service to customers, Trans-Canada Air Lines now have Central Reservations Control Rooms in operation at Toronto and Winnipeg. Previously each airport held a few seats on each plane. Requests are sent by teletype to Toronto and the Central Reservations Control Room replies within about 30 sec. whether accommodation is available. In one day, the Toronto office handled over 2,000 messages concerning reservations, with nearly half from Montreal and Ottawa. All teletype messages are in code. Each message bears the time and sender's code initials. Each city office is known by two code initials. Each TCA office is equipped with a lighted alarm clock set to ring at ¾-hr. before departure time. If the ticket is not picked up before it goes off, the passenger is notified by phone. Space not required is turned over to the waiting list.

MANIFOLD DESIGN ENGINEERING THAT SEES THROUGH SERVICE PROBLEMS

★ ★ In the highly technical ★ field of exhaust manifolds, Ryan "know how" consists of more than the knack of producing in volume and delivering on time. Of initial importance is the ability of Ryan design engineers to see through service problems and solve them on the drawing board. No matter what your manifold requirements may be, Ryan engineering consultation will pay.

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That's where this war is being fought. But . . . it's in the production lines that this war will be WON!

CECO . . . with multiplied productive capacity and over eighty subcontractors . . . producing Aircraft Carburetors, Fuel Pumps, Protek-Plugs*, and Accessories . . . is doing its part to "Keep 'em Flying".

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Manufacturers of Aircraft Carburetors, Fuel Pumps and Accessories.

Aircraft companies working for the Army Air Forces have been requested not to publish quarterly earnings statements until further notice. The request is made on the basis that valuable information might be disclosed to the enemy. That means that stockholders of concerns that contract exclusively with the War Department will receive only semiannual earnings reports in the future. Companies that make a diversified line of products are not included in the suspension.

Douglas Aircraft, following the Air Forces request, left all earnings data out of its first quarter report. The company did report, however, new records in employment, payrolls and production in the first three months of the 1942 fiscal year. "Several million" dollars were spent on plant expansion and nearly $1,000,000 for factory safety devices. More than 90 percent of the unfilled orders backlog is on a fixed-fee basis. While much of this backlog calls for a six percent fee, recent contracts have been reduced to five percent before taxes. The working capital position has been improved since the beginning of the year.

Curtiss-Wright takes care of reductions on aircraft prices when new contracts are negotiated with the government, E. S. Cramer, treasurer, told stockholders at a recent special meeting. Mr. Cramer declined to give any indication of the total dollar amounts involved. At the same time he pointed out, in answer to a shareholders question that the directors were giving consideration to the question of buying in class A stock in the open market.

★ ★ ★ By RAYMOND HOADLEY ★ ★ ★

THE AUTO-AIRCRAFT WAR PROGRAM continues to expand with Nash-Kelvinator Corp., Budd Manufacturing Co. and Goodyear Rubber joining General Motors and Ford in the assembly of complete planes. Of great significance to the aircraft industry is the fact that only Chrysler Corp. and Studebaker Corp., out of the scores of automotive companies now engaged on aircraft work, have announced that they will not continue in the aviation field after the war.

On the other hand Ford and General Motors officials have expressed their intention of continuing in the field in a major way. With such formidable competition looming ahead from the well-heeled automotive industry it is well that most aircraft companies are more concerned today with ending the war with sufficient financial resources to handle their peacetime tasks than they are with wartime profits. The time has come when the aircraft investor should scan the balance sheets of aircraft concerns much more carefully than the earnings statements.

The 1941 balance sheets showed that the huge expansion program has strained the financial position of an industry that has not had as ready a recourse to the financial markets as some of the older industries. Eight aircraft companies last year showed an average inventory increase of 168 percent. As the United States is virtually the only customer of the industry today, the government should shoulder an increased share of this heavy inventory burden. Profit margins of a group of nine big aviation companies declined to 8.5 percent in 1941 from 12 percent in 1940 although per share earnings were at a new peak. Profit margins this year probably will not be much if any above four percent before taxes, which means that per share earnings for most units will be well below 1941.

In order that the industry can continue in a healthy financial condition, the taxing authorities should be lenient in handling of depreciation and other necessary charges. The industry has voluntarily turned aside large wartime profit-making opportunities. But it does need to be well fortified in working capital for the future.

★ ★ ★ ★ ★ ★

United Aircraft's profit on government work, according to Eugene E. Wilson, president, dropped from a top of seven percent in 1940 to five percent in 1941 and will be between two and three percent in 1942. When the company suddenly switched from producing several hundred engines a month to thousands a month, Mr. Wilson explained, the management decided that during the war profits should be controlled and will be kept at around the 1940-41 average.

Passenger traffic on the domestic airlines during the first quarter of 1942 increased 42 percent over a year ago. Citing this amazing gain, Emanuel & Co. recently pointed out that American Airlines alone carried 171,395 passengers in the first two months of this year—which is more than the 152,830 passengers carried by the entire industry in the similar 1939 period.

HERE AND THERE . . . Brewster Aeronautical directors have fixed July 22 as the date for a special stockholders meeting for the election of the board of directors . . . **Cessna Aircraft** earned $2.26 a capital share in the first six months of the 1942 fiscal year as against 35c. a year ago . . . **Briggs Mfg.** is converting another one of its big plants to wartime work on essential aircraft parts . . . **Northwest Airlines** almost doubled its express traffic in the first four months of 1942 . . . **Continental Motors** showed a 340 percent gain in sales in the six months ended April 30 . . . **Ryan Aeronautical** sales and profits in the first half of 1942 were at record levels, according to T. Claude Ryan, president.

ON THE RAW MATERIALS FRONT

THE FIRST PHASE of the aluminum plant expansion program, that of privately financed construction by the Aluminum Company of America is over. The second phase also will be completed on August 1 when seven government-owned but privately operated are in production. All seven federal plants have been completed ahead of schedule; the first two were finished in six months as compared to a normal building time of eleven months.

As a result of these first two white metal programs, aluminum production in 1942 is expected to amount to around 1,000,000,000 lb. as compared to 615,000,000 lb. in 1941, 415,000,000 in 1940 and 328,000,000 in 1939. At the year-end output should be at a rate of 1,450,000,000 lb.

Then there is the third and final phase of the expansion program which will be coming along to provide metal for a good share of the 125,000 warplanes scheduled for 1943. This program was initiated last February and included in large part the construction of plants in several large metropolitan areas that have excess electrical power facilities.

In addition the RFC has contracted to purchase 400,000,000 lb. from the Aluminum Company of Canada. This will bring the grand total available for the war program and the considerable lease-lend needs of the United Nations up to 2,500,000,000 lb. annually in the forefront of 1943.

Thus, when officials are restricting civilian industries to get enough steel, copper, nickel and rubber for the ship, tank and gun programs, it is reassuring to note that sufficient aluminum output has been scheduled to meet the 185,000 two-year warplane program and, in fact, enough leeway allowed in these expansion plans to permit some further extension in the present huge aircraft goals.

War Production Board officials readily back up the aluminum industry's claim that there is an ample supply of aluminum ingots available for all essential war purposes, including battleships and ordnance as well as aircraft. Aluminum, of course, accounts for 90 percent of the weight of the average combat plane and 50 percent of its engine.

In order to avoid unnecessary aluminum shortages a new materials procurement plan has been adopted under which the aircraft industry and other war industries will make known their probable material requirements sufficiently far in advance to permit the WPB to guarantee adequate supplies of aluminum when and where needed.

At the same time engineering departments of 25 aircraft manufacturers, according to the Aeronautical Chamber of Commerce, are coordinating their efforts toward standardizing and reducing the large number of extruded aluminum shapes so essential to warplane construction.

At present there are in possession of Aluminum Company more than 5,000 drawings covering extruded shapes. When this number is reduced by the various aircraft companies, functioning as the National Aircraft Standards Committee, more than one company can utilize identical parts.

Great Bombers on Little Casters Grow!

IT'S A NEW IDEA... FROM NOSE TO TAIL BASSICKS HELP ROLL OUT THE B-24'S

Putting thousands of pounds of fighting fury together (and doing it *fast*) is what's going on here—the rapid and mobile assembly of a Consolidated B-24 . . . first bomber in history to actually *roll* off an assembly line.

Practically every part of these mammoth Land Bombers is assembled on easy-rolling Bassicks. Fuselage, Nose and Wing Sections are wheeled into production—on Bassicks.

Work Platforms, Stepladders, Equipment Shelves and Testing Units travel right with the job—all on Bassicks.

It's the new idea in plane assembly—an idea that is helping Consolidated Aircraft Corporation hatch out B-24 Bombers and Coronado Flying Battleships faster than you'd guess!

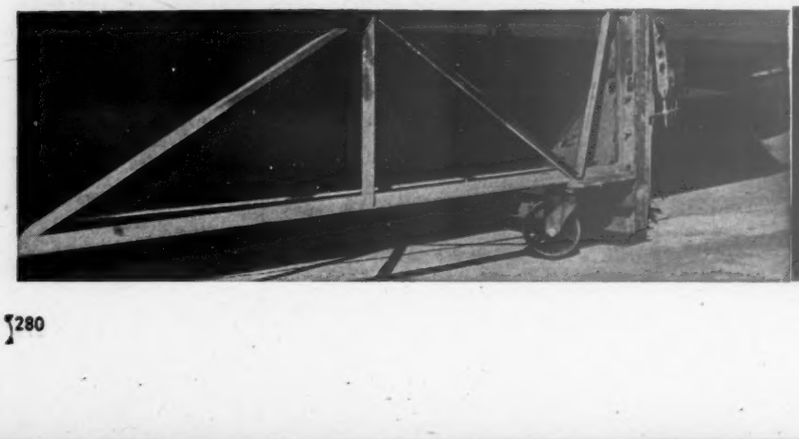
Maybe it would speed up *your* production. Whatever you make—if it has to be moved—get it going faster and easier on Bassick Casters.

WORK PLATFORMS, which surround the big bombers, roll on Bassick Casters as they move down the assembly line. Shown above: worker attaching Bassick Caster to plate.

TESTING EQUIPMENT (above) for checking the Bombers rolls right up to the job on Bassick Casters.

SHOWN BELOW: B-24 Fuselage on its way into the production line on easy-rolling Bassicks.

CENTER WING SECTIONS of Consolidated Coronado Flying Battleships (here shown on their sides) are rolled right up to the assembly line on Bassick Casters.



BASSICK CASTERS

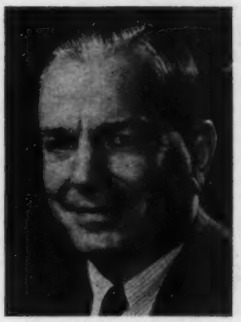
THE BASSICK COMPANY... BRIDGEPORT, CONN.

WORLD'S LARGEST MANUFACTURERS OF CASTERS

Two new appointments at the Tennessee Division of Vultee Aircraft, Inc., involve **OTTO R. STOCKE** (left), and **AMBERSE BANKS** (right). Stocke, former chief financial officer at that division, has been made assistant to D. I. Carroll, vice-president in charge of all Vultee production, a position which will require much of his time at Stinson division and with subcontractors. Banks has been appointed flight operations manager, in charge of flight testing and flight ramp operations. He will be assisted by Cy Younglove, chief test pilot.

REAR ADM. JOHN H. TOWERS, Chief of the Bureau of Aeronautics, has had added to his duties direction of the Naval Air Transport Service as he assumes title of Assistant Chief of Naval Operations (Air), in charge of personnel, equipment and air bases.

New chief engineer at Ryan Aeronautical Co., is **BENJAMIN T. SALMON,** who previously had served with Martin, Lockheed, Northrop and Vultee. Other Ryan promotions made Millard C. Boyd development engineer and Will C. Vandermeer chief project engineer.



JOHN M. ROGERS, v. p. in charge of Douglas Aircraft Co., sales, and for years the company's Washington representative, who has been assigned the role of coordinator for Douglas' worldwide activities in assembly and servicing of military airplanes.

DEVON FRANCIS, well known aviation writer, has joined Time magazine following five years as Associated Press aviation editor. A licensed pilot and four-time president of Aviation Writers Association, he has flown more than 125,000 miles covering aviation assignments.

WILLIAM P. GWINN, named to the post of assistant general manager of Pratt & Whitney Aircraft Division of United Aircraft Corp. Starting with the company in 1927, Gwinn has been asst. sales mgr. the past two and a half years, following six years as West Coast representative.

A. L. KRESS, widely known industrial engineer and former industrial relations engineer and consultant to the Aeronautical Chamber of Commerce has been named assistant to the president of Republic Aviation Corp: to handle personnel, educational, employment and public relations.

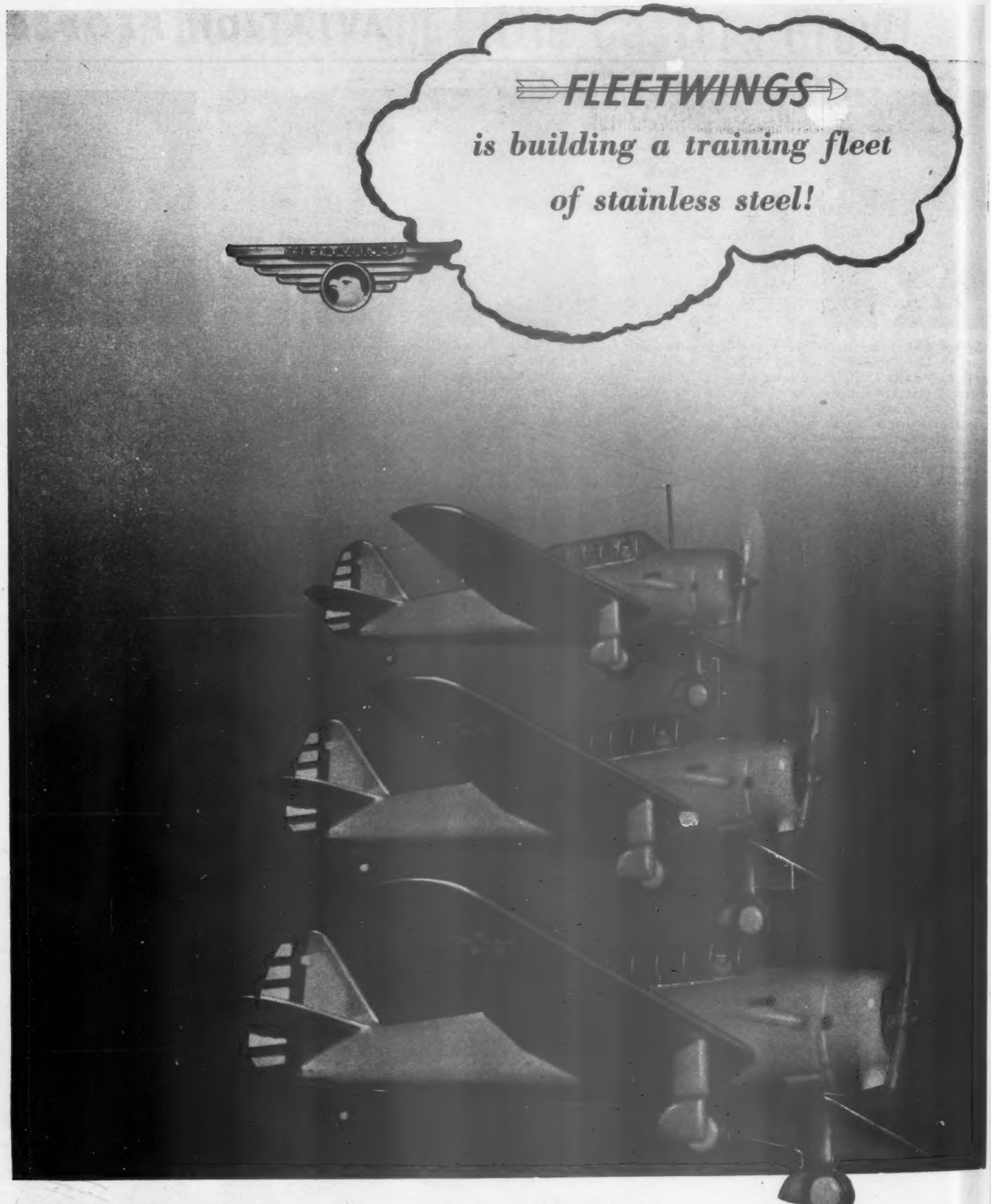
R. W. IRELAND (left), since 1932 traffic manager of United Air Lines, has been granted leave of absence to head the newly established Air Division of the Army Transportation Service, with headquarters in Washington. He has been in air transport since 1926, when he joined NAT, a United predecessor. **CAPT. WARREN D. WILLIAMS** (right) has been named flight operations superintendent for United's eastern division, "Bill," learned to fly with the Army Air Service in France in 1918, and for the past five years has been flying out of San Francisco on United's western division.

LEON WOLFE has been appointed quality control engineer for Aeronca Aircraft Corp., charged with quality supervision of all L-3-B liaison craft being built for the Army as well as for all other models in production. He has been with Aeronca since 1939.

MISS KAY BODDE (left), who has joined the ranks of women taking over duties of men now serving with the armed forces. She has been placed in charge of the New York office of Northwest Airlines to succeed **GORDON MACLAREN** (right), who has gone on active duty with the Navy as a lieutenant (j. g.). Miss Bodde broke into aviation ten years ago in her native Kansas City, first as an assistant to the manager of Fairfax Airport and then with Transcontinental & Western Air for five and a half years before going to New York.

New advertising director for Fairchild Engine & Airplane Corp. is **JOSEPH E. LOWES, JR.,** former director of advertising and publicity for United Aircraft Corp., and more recently a member of the account executive staff of Ruthrauff and Ryan, Inc., advertising.

A. R. MENSING, JR., Northwest Airlines western division superintendent and an outstanding authority on instrument flying, has gone on active duty as major with the Army Air Forces. He has been flying since 1921, and has been with NWA since 1929.



PILOTS who expect to fight for Uncle Sam have to be tough . . . and so do their planes! Fleetwings, along with its parts production for leading military aircraft, is now building a basic trainer, the BT-12, for the U. S. Army Air Forces. . . . Flyers report that this new plane can really "take it."

Specifications of the sturdy, maneuverable BT-12 . . . the world's first military plane built principally of stainless steel . . . include a 40′ span, an overall length of 29′ 2″, and a 450 h.p. Pratt & Whitney engine for the power plant.

Designing and building this airworthy ship came naturally to Fleetwings engineers . . . because they have long been recognized as pioneers in developing the spot welding, stamping and fabricating of stainless steels for aircraft and parts.

Fleetwings continues to pioneer. . . . even while keeping ahead of today's big production schedule . . . so that tomorrow's tougher and faster warplanes will reflect American ingenuity "revved up" to a new high!

★

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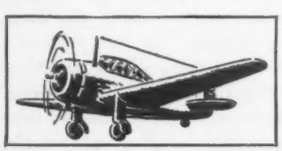
AHEAD OF PRIME CONTRACTORS' REQUIREMENTS is the record of Fleetwings' production men and women . . . who are intent on putting a dent in the Axis. Their speed is important, for they're building wings and control surfaces for many leading fighters and bombers.

"KNOW-HOW" PAYS OFF: Fleetwings has stepped up total output about two thousand percent in thirty months by putting these seven principles into practice:

(1) Mass-production of aircraft parts by mobile production.
(2) Simplification of each production job into one or two operations.
(3) Intensive use of experienced supervisors.
(4) An efficient training school to feed in pre-tested men and women.
(5) Moving jigs, conveyors and other mechanization to keep 'em rolling.
(6) Detailed budgeting of time, materials and money.
(7) A "flying squad" of engineers on special assignments . . . spotting production flaws and inventing improved techniques.



"ATTACK PLANT": Now that you know how Fleetwings builds 'em, you'll be interested in the alert attitude of the Fleetwings organization . . . from top to bottom. Back in March, we had our "Defense Plant" sign painted out, and substituted "*Attack* Plant." Fleetwings aircraft parts and hydraulic equipment are putting that slogan into sky-battles!

"KEEP 'EM FLYING!"

FLEETWINGS
Incorporated
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Recent Books

VICTORY THROUGH AIR POWER, *by Major Alexander P. De Seversky. Published by Simon and Schuster, New York. 354 pages. $2.50.*

It would be a pleasure indeed to be able to report that this book provided answers to at least part of the vital questions of today or tomorrow. Unfortunately, however, such is not the case for the book must be set down as so glib, specious and contradictory that it leaves the reader in a serious state of confusion with respect to air power.

If we were not at war *today,* certain portions of De Seversky's book might be read with amusement, as is Buck Rogers. If the millions of people in the war industries and on the fighting fronts were not working their hearts out in a constructive effort to win a victory *today,* the turning of such energies to destructive criticism might properly escape notice. If we could rub an Aladdin's Lamp to secure much desired equipment, or if we could visualize the American people accepting instantaneously and without question some revolutionary economic and political concepts, we might begin to understand a few of the "tactical" recommendations that are so vaguely presented.

From the omnipotence of hindsight everyone, it seems, is wrong but the author. The French were utterly hopeless, even liars bound by crooked politics and blind patriotism. The British were more "realistic" but still hopelessly fettered by business and politics. The Germans built entirely the wrong kind of air force. It was, depending on what part of the book one considers, nothing more than an auxiliary controlled by the earth- and sea-bound forces or, as he says later, "the elementary fact I can attest from study on the spot, is that the Luftwaffe is wholly separate and autonomous. Its status is no different from that of the Navy or the Army in the Reich." Our own "brass hats," in scathing denunciations which could be uttered only in a democracy, include men who have been "criminally negligent" in keeping America without what he calls air power of any kind.

To the uninitiated the book appears plausible, but to anyone who can tell an aileron from an apple, it is soon evident that its "strategy" calls for winning today's war with the future's planes. Repeated references to projected or, at best, experimental planes as though they were available in quantities, or could be made so immediately, can only be interpreted as artificial premises upon which to make a point.

For instance, the author refers glibly to the "new Douglas B-19 and the Glenn Martin flying boat, with their range of nearly 8,000 mi. and their ability to carry a bomb load of 18 tons," coupled with Mr. Martin's announcement of a projected 250,000 lb. craft that "will be able to carry 20 tons of explosives to any part of Europe and return nonstop." His next paragraph states that "present Douglas and Martin superbombers have neither the speed, the armor, nor the armament to make them true dreadnaughts of the skies." Yet, little more than 100 pages later he says "our own B-19 and the Glenn Martin flying boat can deliver nearly 20 tons of explosives or 20 torpedoes." How the B-19 with its alleged inferior speed, armor and armament *can* deliver bombs in a combat zone is left unexplained. And, since the author never makes clear whether reference to the Martin craft means the *Mars,* just now undergoing flight tests, or the projected plane still on the drawing boards, it is not explained how either could successfully bomb any European combat area.

Again, in the chapter on "The Twilight of Seapower," in which navies are literally written off the seas, the following is offered to bomb battleships to the bottom: "take, for example, the B-19 superbomber. It has a wingspread of 200 ft., which is twice the width of the beam of a modern battleship or carrier. By locating the bombs in the wings, the breadth of the salvo pattern can be extended to 100 ft." The complete redesign and reconstruction of wings alone, thus made necessary, is utterly ignored.

And still again, in this same chapter, the author declares that "accuracy of bomb sights has been raised to a remarkable degree and is being constantly refined," stating that bombing even "under combat conditions" from 30,000 ft. should hit a circle 600 ft. in diameter; "from 20,000 ft. the bomb should fall within a circle only 200 ft. in diameter." But again, within 100 pages, in a criticism of the Boeing B-17, the author states that the public is being fooled into believing that the *Fortress* can attack from great altitudes "—as high as 35,000 ft." He goes on that, "every additional foot of height means a loss of accuracy. Besides, there are relatively few days when visibility permits bombing from that altitude, so that valuable equipment is left idle the greater part of the year."

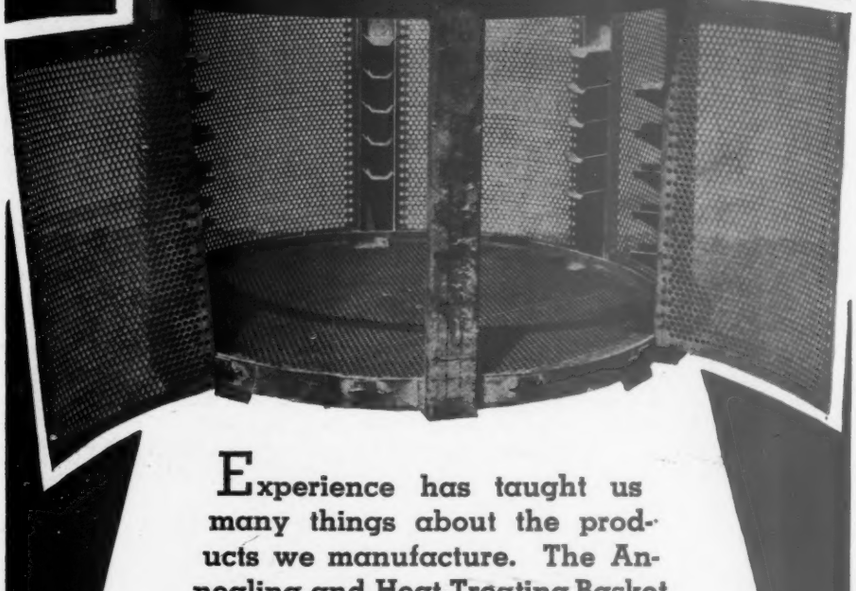
"The citations could go on for pages," to use the author's own words as he delivered one of a long series of invectives against the Army and Navy "brass hats."

Even an impassioned plea for a sepa-

BETTER PERFORMANCE FOR QUICKER VICTORY

EXPERIENCE COUNTS

IN THE MANUFACTURE OF PRODUCTS LIKE THIS!



Experience has taught us many things about the products we manufacture. The Annealing and Heat-Treating Basket shown above is an example of what careful workmanship, rigid inspection and good material can accomplish.

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rate Air Department—which would release as if by magic the nation's apparently stifled aeronautical genius and immediately produce unlimited "dream" planes—is weakened by speciousness and contradiction. After declaring unequivocally and repeatedly that navies are already secondary and can be quickly bombed to a state of "atrophy," De Seversky declares that "ship-borne aviation must be integrated with the Navy. Whether taking off from aircraft carriers or warships, it is intended primarily to operate in areas still beyond the reach of existing land-based aviation. It is physically as well as tactically joined with the Navy as submarines or naval artillery or smoke-barrage apparatus." This, after ostensibly proving that ship-borne aircraft are vastly inferior to land-based and that carriers are, to say the least, a foolish waste.

It would indeed be wonderful to see them today—swift, giant bombers streaking from mid-continental United States to any part of this "interglobal" warfare with bomb loads capable of "annihilating" any enemy. They would, of course, be escorted by the "author's *concept* of the lines of development in long-range interceptors."

PLANT PRODUCTION CONTROL, *by Charles A. Koepke. Published by John Wiley & Sons, Inc., New York. $4.00.*

Though prepared for students in industrial engineering, this book is far from being a mere academic treatment of the subject. The author, a professor of industrial engineering at the University of Minnesota, was given the run of many large industrial plants before writing the book and found that no two follow the same control system. All had a pattern of functions which tended to be more or less constant, says the author, and this pattern is developed in the book although the book is based also on notes used in teaching and resulting from experience while working in industrial plants. No one system of control is advocated, since none seems to fit all plants, but there has been an effort to resolve the problems into necessary functions and to study the latter and their inter-relation.

The book aims to deal with a maximum production of goods with minimum confusion and expense and may well serve as a reference for those interested in such an objective. As the book concerns itself broadly with all industry, it applies to the aircraft industry only as it does to industry in general. To the practical industrial engineer such chapters as the following appear likely to be of greatest interest: Product Analysis, Planning and Routing Production; Estimating Production Requirements

and Costs; Centralized Control of Production; The Use of Planning Records for Certain Costs; Measures of Factory Performance. Each chapter is followed by a bibliography which should be helpful to those wishing a still more comprehensive study of the subject than the book itself affords.

THE AIRCRAFT YEARBOOK FOR 1942, *edited by Howard Mingos. Published by the Aeronautical Chamber of Commerce, Washington, D. C., 690 pages, illustrated. $5.00.*

The necessity for dominant airpower and how American aviation is achieving it form the keynote for the 24th annual edition—the largest yet—of what has become the standard reference work on the nation's aircraft industry. Editor Mingos maintains the high standards established in previous editions through the eleven chapters, bulwarked by nearly 400 illustrations. The new yearbook covers the war in the Americas; United States airpower to determine victory; both the Army and Navy Air Forces; training and education; civil flying, both government and private; transport activities; airports and airways; the manufacturing industry and miscellaneous activities.

AIRCRAFT INSPECTION, *by Ernest E. Wissman. Published by Whittlesy House, New York. 258 pages, illustrated. $3.00.*

A complete, well illustrated book designed to assist in standardization of quality and safety of aircraft by giving practical, authoritative information on factory inspection methods.

Purposely general in nature to avoid any thought of changing existing principles established by manufacturers, it covers all steps of inspection routine from fabrication and subassembly through pre-flight and delivery inspection of the completed plane.

GAGES AND THEIR USE IN INSPECTION, *by Fred H. Colvin. Published by McGraw-Hill Book Co., Inc., New York. 154 pages, illustrated. $1.50.*

A fundamental study of vital equipment for precision manufacturing, it explains how gages are constructed as well as used and clarifies many terms and questions which commonly cause misunderstanding in confusion in shops. Also covered are: measuring instruments commonly used; gage types; tolerances and gage wear; gage blocks and dial gages; reed and air gages; threads and thread gages; special types; interchangeable manufacturing and inspection; salvaging and selective assembly and kinds of fit.

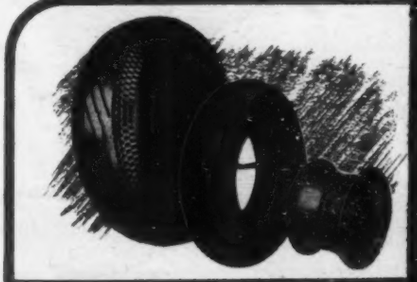
THE TRUCK-MAN

built by Yard-Man, Inc., Jackson, Mich., is shown here carrying a 2200-lb. load of motors. The traction required for speedy operation and easy maneuverability, and the cushioning necessary for the gasoline motor are provided by two 14-inch, 6-ply General Jumbo Jr. Industrial Pneumatics.

GENERAL TIRES SPEED UP
Factory Transportation, Too

HELPING to speed the transfer of materials and parts—heavy loads . . . delicate equipment . . . all types of products—General Jumbo Jr. industrial pneumatic tires are fighting on America's Factory Front, as well as on many types of equipment employed directly by our armed forces.

The soft, cushioning effect of this pioneer industrial tire-tube-wheel combination protects factory floors, the load, and the truck itself against damage from jarring. Exclusive wide rim provides extra stability. The tire will not pick up chips, filings, etc. from floors. Tire life is far greater. Traction is better—it is practically impossible to spin Jumbo Jrs.



Tires 8" to 24" overall diameter. Load capacity 100 lbs. to 1500 lbs. per tire. 2- 4- 6- and 8-ply with separate tubes and heavy-duty wheels.

For further information, write,

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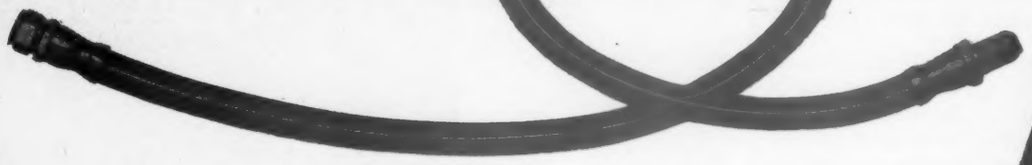
GENERAL JUMBO JR.
INDUSTRIAL BALLOON TIRES

Arteries for Air Armadas

WEATHERHEAD Flexible HOSE



VITAL mechanisms in modern military planes for take-off, flying, fighting and landing depend upon *hose* for the flow of the forces of power. Every assembly must withstand the toughest front line demands—failure of the hose may mean failure of the plane.

Weatherhead High, Medium, and Low Pressure Flexible Hydraulic Hose Assemblies are used on every type of military and commercial plane. They serve steadfastly under heat, cold, strain, vibration, and varying pulsations of pressure. Weatherhead high-quality, large-scale production is your assurance of the highest standard in "arteries for air armadas."

Other Weatherhead airplane parts include Dural Tube and Pipe Fittings; Vacuum Selector and Check Valves; Hydraulic Check Valves; and Hydraulic Actuating Cylinders. All are manufactured to Air Corps, Navy, or "AN" specifications.

THE WEATHERHEAD CO.

AIRPLANE DIVISION

Main Office: Cleveland, Ohio

East Coast Office: New York, New York

West Coast Office: Los Angeles, California

WEATHERHEAD

America At War

(*Continued from page 89*)

an average bomb load of just less than two tons per plane. On that basis, 3,000 airplanes could drop 5,500 tons of bombs over Germany in one night.

Whether these facts, released by the *British Press Service*, are intended to imply a move toward more four-engine planes, you can speculate for yourself. It is interesting to note that when an air force is not strongly opposed, as RAF is not now strongly opposed over Europe, it can worry less about having too many eggs in one big-plane basket.

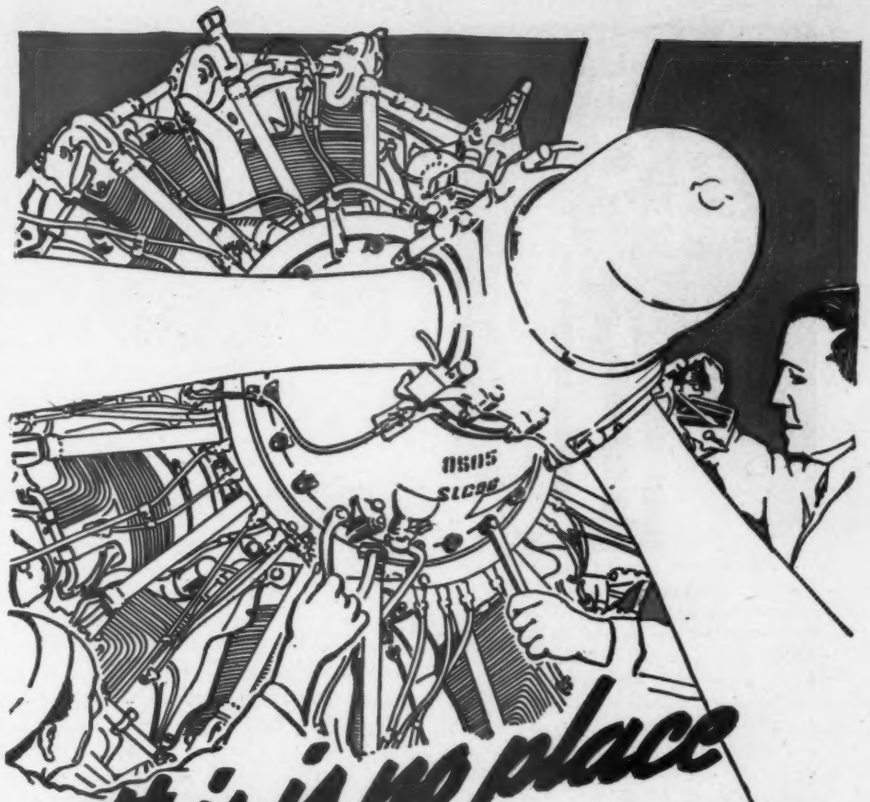
To whatever boom the English can let fall from the air on Europe, the United States will soon add a substantial force. Air Chief Gen. H. H. Arnold was in England talking business; Supply Chief Gen. Brehon Somervell was there, and Gen. George Marshall, Chief of Staff, told the West Point graduating class the other day that "American troops are landing in England and they will land in France."

As this communique has said before, you may yet witness the proof whether, given enough airplanes, an air force can totally reduce a city, rendering it untenable and useless in a war effort. No one knows how near the Germans came to doing just that to London and Plymouth and Coventry—apparently not very near.

On the other side of the world, the Chinese say they have constructed air bases within bombing range of Japan, and they are not asking the United States to do the bombing for them; they say they want the planes and they will roll their own. No doubt though, the United States and several other countries will be glad to take a ride eastward from China's bases when the time comes.

There is no official word at all on the prospect of bombing bases in Russia. The Soviet probably would not give away bases just to have Japan climb on her back. The experts say that when Russia gives bases on the Pacific, it will be in return for the opening of a united front in Europe, to pull some of Hitler's hosts off the Russian battle line.

All in all, the Japanese are giving a good account of themselves, on land, sea and air. Their airplanes are not as good as British and American planes, but they're good enough, and their pilots work hard at getting the most out of them. The *Zero* fighter turns out to be quite hot stuff, in performance. It makes up to 400 mph. because it's light and sleazy, but it is no match in strength for its English and American counterparts which can fly just as fast. Incidentally, the *Zero* looks very much like



This is no place for a LOOSE NUT

. . . and that goes too for thousands of other vital positions on America's fighting airplanes where careful designers have placed Elastic Stop Nuts. These self-locking self-gripping fastenings have proved, through fifteen years of reliable service on aircraft, that they remain tight under all combinations of vibration, stress, shock, exposure to weather, and prolonged heavy duty. They are used today on *every* military and transport airplane built in the Western Hemisphere.

There are more Elastic Stop Nuts on America's airplanes, tanks, and other war equipment, than all other lock nuts combined.

ELASTIC STOP NUTS may be the solution to *your* fastening problems. Sample nuts, for testing, will be furnished without cost or obligation.

» Write for interesting folder explaining the Elastic Stop self-locking principle.

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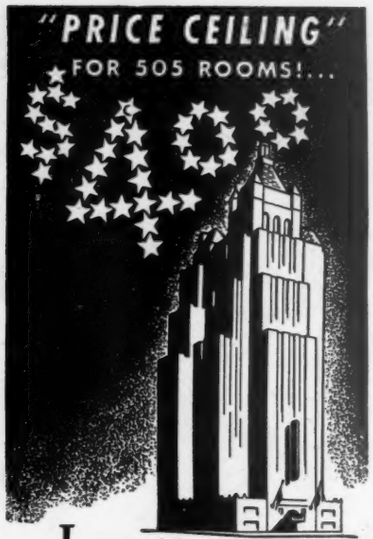
WITH THE RED LOCKING COLLAR . . . SYMBOL OF SECURITY



In 1939, The Lexington established a minimum rate—*and has not raised it since!* More than one-half the total number of rooms in the entire hotel are, now as before, priced at $4... *all outside with combination tub and shower, circulating ice-water, full-length mirror and four-station radio.* Double rooms from $5.50; suites from $12... at *"New York's Friendly Hotel."*

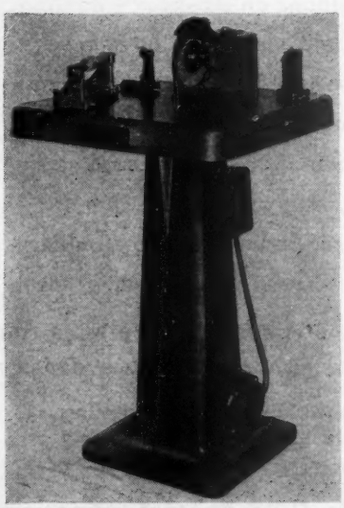
Hotel Lexington

Charles E. Rochester, Vice-Pres. & Mng. Dir.

LEXINGTON AVE., AT 48TH ST., N. Y. C.

Fast and Accurate Formed Cutter Grinding with the

BARNES *Precision* Cutter Grinder



Fast grinding of formed cutters with assurance of preserving form exactly and lengthening cutter life 5 to 8 times. The BARNES will grind gangs of formed cutters—plain, concave, convex or angular—shell tools—shank tools—form turning tools—cutters with undercut and spiral teeth.

WRITE FOR CATALOG

General Machinery Corp.

JOHN P. TIERNEY, *President*

140 Federal St. Boston, Mass.

the famed Nazi Rocke-Wulf FW 190H.

The *Zero* was the only plane able to come up with the B-25's used by Doolittle in his raid on Japan. And you should know that this raid is liable to be repeated at any time—that is, it can be, until such time as the Japanese find out where it came from. They would have little more defense against another than they had against the first.

It was nice, dishing that bombing to Japan, but Under Secretary of War Patterson says Japan almost certainly will try to dish it back at us. The shame of losing face in the Orient hardly permits them to do otherwise.

Cargo Outlook

One more point on Doolittle's raid: some people have amused themselves by dividing 79—the number of men decorated—by five, the number of men in a B-25 crew, and getting a total of 16 planes in the attack. Anybody who can work short division can do it—but he still won't know whether *all* the men were decorated, or whether the ships carried full crews.

If the little sons of heaven feel embarrassed about the attack, they also may be feeling very sorry indeed about their five new 40,000-ton battleships. Japan and England, both strong sea powers, have had the pain of demonstrating their own weakness by sinking other people's battleships with airplanes.

Here at home, we are working on air cargo in a way that grips the imagination. We haven't enough surface ships to haul our own oil, let alone our Lend-Lease war supplies going abroad. The submarines keep knocking down our tonnage by the clock, and the remedy is slow coming. Meanwhile, imaginative people in and out of the services keep arguing that a biggish cargo plane can make so many more trips from A to B than a surface ship can make that in the end the airplane will have delivered the most stuff. It doesn't sound right, because an airplane is little and flimsy and nervous. Some of the more settled boys have difficulty adding it up. Just the same, a rather amazing number of cargo planes, in existing designs, have been ordered by the Army, and practically all of the big manufacturers are designing whoppers. Glenn Martin has announced his big six-engine plane, and it is shown in this issue on page 93. But these two giants are scheduled for post-war development.

What may come of this air cargo idea is anybody's guess. The Army is already moving surprisingly big volumes of stuff by air, and officers say they are amazed at what has been done in China and in Africa.

Back in our first paragraph we said the Axis' defeat can now be visualized. Churchill said not long ago that we can now see over the ridge for the first time. Always before, the Germans and Japs had won, at every turn of the cards. Now it's different. They have been stopped, and their murder of many hostages is a symptom of their fright. But everywhere we are warned not to turn our back on this wounded beast for an instant. It might fight on and on and on.

Incidental intelligence: Berlin says Blohm and Voss is building a plane with its motor and steering gear on the left wing and a nacelle for a crew of three on the right. It sounds a bit groggy but the Germans say it works, for "special purposes," on the Russian front.

Army and Navy say they are going in for gliders and glider training in a big way. Not long ago they both testified against extensive motorless flight, so what's up we don't know.

Comdr. Edward Binning, in a *Catalina* boat, destroyed an Axis submarine with bombs and armor-piercing gunfire. It would be interesting to know which did the job.

Undersecretary of War Patterson says that the President's goal of 60,000 planes in 1942 will be exceeded by a good margin. If so, the achievement will be greater than appears at first thought, for we have shifted far more into heavy bombers since the President set up the objective.

Water-Based Airplanes

(*Continued from page* 93)

On smooth land, even as compared with smooth water, nobody had to bother with such factors as flotation, watertightness, spray and porpoising; so when the point was reached where the waterplane would have to be a different animal on the surface in order to give the same results in flight (just as the two engine types referred to are quite different animals although they turn the same propellers) the landplane—quite excusably—was given the right of way in development. Thereafter everything has been thrown the way of the landplane, until most people have quite lost sight of the fact that the majority of modern landplanes could not fly at all if they had to use the landing fields of ten or even five years ago as we should already have learned from Norway, Crete, Malaya and the East Indies. The best that has since been done for the waterplane is to mount a landplane on a pair of heavy high-drag floats or to mount a landplane superstructure high above a hull bottom which has remained essentially unchanged for some 30 years, the principal

(*Turn to page* 291)

Dear Pop:

Even an old Rainbow Divisioner like you would pop your eyes at the army we're putting together this time. Let me tell you, they're doing everything to make up just about the best bunch of fighting galoots you ever saw.

And that goes for what they do for us off duty, too! Take this new clubhouse we got just outside of camp. It's got radios, dance floors, nice soft chairs and everything. And, Pop, you can get something to eat that won't cost you a month's pay!

Now, the army isn't running this. The USO is. And most of the other camps got USO clubs too, because you and a lot of other folks dug down and gave the money to the USO last year.

But, Pop, you know what's happened since then. Guys've been streaming into uniform. Last year there was less than 2 million of us. This year there'll be 4 million. And the USO needs a lot more dough to serve that many men—around 32,000,000 bucks I hear.

Now, Pop, I know you upped with what you could last time. But it would sure be swell if you could dig into the old sock again. Maybe you could get some of the other folks in the neighborhood steamed up, too.

It will mean an awful lot to the fellows in camp all over the country. Sort of show 'em the home-folks are backing them up. And, Pop, an old soldier like you knows that's a mighty nice feeling for a fellow to have. See what you can do, huh, Pop?

Bill

Send your contribution to your local USO Committee or to National Headquarters, USO, Empire State Building, New York, N. Y.

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reason for the height being to keep the landplane propeller arrangement out of the water. Immense development has been put into retractable landing gears but, since retracting *floats* are impracticable, nobody seems to have even thought about retractable *flotation*.

Another reason for lack of waterplane development is, in fact, the state of affairs which has led to the modern flying boat. In earlier days the waterplane was always expected, and in most cases was able, to look after itself. Journeys into the unknown were nearly always by waterplane; for landplanes one had to be sure of some adequately prepared surface—and the more recent the landplane the more the preparation required. Gradually the waterplane was expected to get down in worse and worse places, finally working up to the open sea and the flying boat. If landplanes had been equally expected to get down and up in equally unprepared spots, the modern landplane would not even have anything like the performance the flying boat has today. Instead it was allowed to confine itself to ever-lengthening strips of smooth concrete, without which it cannot operate. Yet the type of airplane so confined is the only type which has undergone extensive development.

Destroy or capture its concrete strips and the landplane is knocked out. Yet, for some strange reason, nobody seems willing to consider starting waterplane development from a smooth water basis. As soon as one mentions a waterplane fighter one gets the comment: "Yes, but you will never be able to get that off a rough sea." Nobody complains that a P-40 cannot take off a boulder-strewn field.

There are three principal replies to that comment, but we have become so landplane-minded that few people can be found to listen to them. They are: (1) There are immense areas where even a smooth-water design can take-off, especially in the present war zones, and additionally, such a plane could almost always find and get down safely in far rougher water than it could take-off from, (2) improvements in landplanes are obviously requiring more and more elaborate surface preparations, improvements in waterplanes are likely to make them still more adaptable to varied surface conditions, (3) increase in landplane size may soon run into strict limitations which will be imposed by the great surface preparations required—expensive in peacetime but hopelessly vulnerable in wartime. With the waterplane, increase in size decreases its dependence on smooth surfaces. The point here is that the development of the waterplane has never been conceded anything like the same surface assistance that the landplane has had; in other words, it has never been allowed to start from the beginning.

Again the waterplane has always been subjected to advance and plausible disparagements of its possibilities which have gravely discouraged study of their actual value. Many of these disparagements have been based on actual facts, because I think that in any case the waterplane is a *more difficult* type to develop. The error lies in concluding from those facts that it must be a *less efficient* type. It is never possible to meet these criticisms point by point, only the whole and final result can meet them. To illustrate this one may return to our liquid cooled engine analogy: One is told that it must have a much longer and hence much heavier crankshaft, it must have a heavy radiator, and must carry gallons of coolant liquid with pumps, pipes and plumbing, so it cannot possibly compete with the air-cooled radial. All perfectly correct—except for the conclusion.

The fact that the landplane has been given all this preference in development is a quite natural state of affairs. Except for a few special purposes, and under conditions where land bases were hard to find, the waterplane filled a less extensive need than the landplane. It is my contention that present war con-

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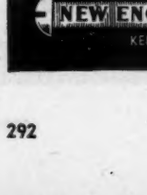

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KEENE, NEW HAMPSHIRE
INCORPORATED 1892

ditions have changed the whole outlook in this respect, and we have arrived at the point where we must regard the waterplane not as an inevitably inefficient type of airplane but merely as a comparatively undeveloped one. When we come to the technical features of these notes, we shall see that the landplane is by no means the natural and inevitable development of the airplane; it has just happened that way.

Some of the war necessity for adequate waterplanes are obvious, apart from those already referred to in the foregoing remarks. It must be noted, however, that if the waterplane continues to have inferior performance it will be severely limited in usefulness because its operations must inevitably bring it into conflict, from time to time, with the enemy's landplanes and it must be able to meet them on equal terms.

There is, however, one aspect of the future of waterplanes of which the outlines are a little dim at the moment but which, as it gets clearer, indicates the immense practical probability, not the dreamer's vision, that one class of craft will be needed for the command of both air and sea: the air "battleship" with its attendant "destroyers" and "cruisers." That such craft shall be based exclusively on land is inconceivable; it may even be almost impossible. Let us examine a few facts.

For 20 years it has been argued as to whether an airplane could sink a battleship. There was, in fact, never any argument about it, for even if *today's* airplane *couldn't* sink a battleship, then there was bound to come some day when larger air bombs, dropped with more accuracy from airplanes with more speed and more range *could* sink a battleship. Today we know beyond argument that a battleship can survive in the presence of airplanes only if the aim of the latter is sufficiently inaccurate or if the bomber is shot down by defending airplanes before it can aim. What the battleship can do to defend itself is already almost negligible.

Water Base Is the Answer

But what is going to happen in the day, now not far distant, when the bomb remains under control after it is dropped—and not necessarily under the control of the bomber which dropped it? What surface ship is going to be able to survive the almost complete certainty of a direct hit? And where are the defending fighters to come from unless the ship sticks close by its own shores? For the aircraft carrier, with its landplanes, is not going to have much hope either.

Today it is admitted that aircraft cannot capture or hold a land objective. Why this is "admitted" I don't know. They took Crete. Admittedly the defenses of Crete were primitive, but so also were the means and methods of aerial attack. It is probable that the dropped bomb will be more accurate and far more devastating than artillery.

Only the surface of the water offers a reliable base from which such huge airwarships of the future will be able to operate and, in some cases, they will perhaps cooperate with under-water craft for some degree of supply. At any rate, since no surface vessel will have much chance to survive, the war will move above and below the water.

At the very least the probabilities are that the water-based airplane must receive a degree of attention such as it has rarely or never had before, and vastly increased support must be given to its development.

Altschul

(*Continued from page* 258)

are constantly assuming increased Army cargo work and other military operations of various kinds. As this trend continues, it is likely that the airlines may be operating more planes, under contract than it had in all of its pre-war commercial service. On the whole such operations should prove profitable and more than compensate for the loss of commercial business.

The airlines are also favorably situated on the tax question. They are not subject to any excess profits taxes but under the pending measure, are faced with only a top tax of 40 percent covering income and surtax rates.

Then there is the ever-glamourous future of the airlines which receives new impetus almost daily in current military developments. The "romance" attributed to a growing industry by the investing public is always difficult to evaluate. Past history however, shows that the outlook for a growth group has been reflected far in advance of the actual realization of successful accomplishment. For example, aircraft issues sold about twice present levels in 1937 and 1938 when the sales of the entire industry were only about one-fourth that of the current billings of one company such as United Aircraft. Similarly, the distilling shares were materially higher in 1933 than later when repeal was rapidly becoming an old memory.

The stock market is constantly attempting to discount the future rather than to reflect the present. This attempt to visualize the nature of our post-war economy may impart dynamic qualities to airline securities.

The danger is always present that excess speculation may be conducive to false conceptions and values for an industry that will have need of a strong, constructive financial policy as a basis for sound and continued growth.

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RAF Aircraft Training

(*Continued from page* 95)

tiative is taken, the manpower problem will become increasingly difficult in the United States as it has here, especially in such a specialized branch of industry as aircraft engineering. Despite personnel problems at home, United States firms should, if at all possible, extend their servicing arrangements here, and one man to act as liaison to RAF squadrons in maintaining his company's products at high pitch is well worthwhile. The RAF greatly appreciate such a gesture while the advertising side of 100 percent service and the good will it creates is an important factor which United States firms in peacetime have always kept before them.

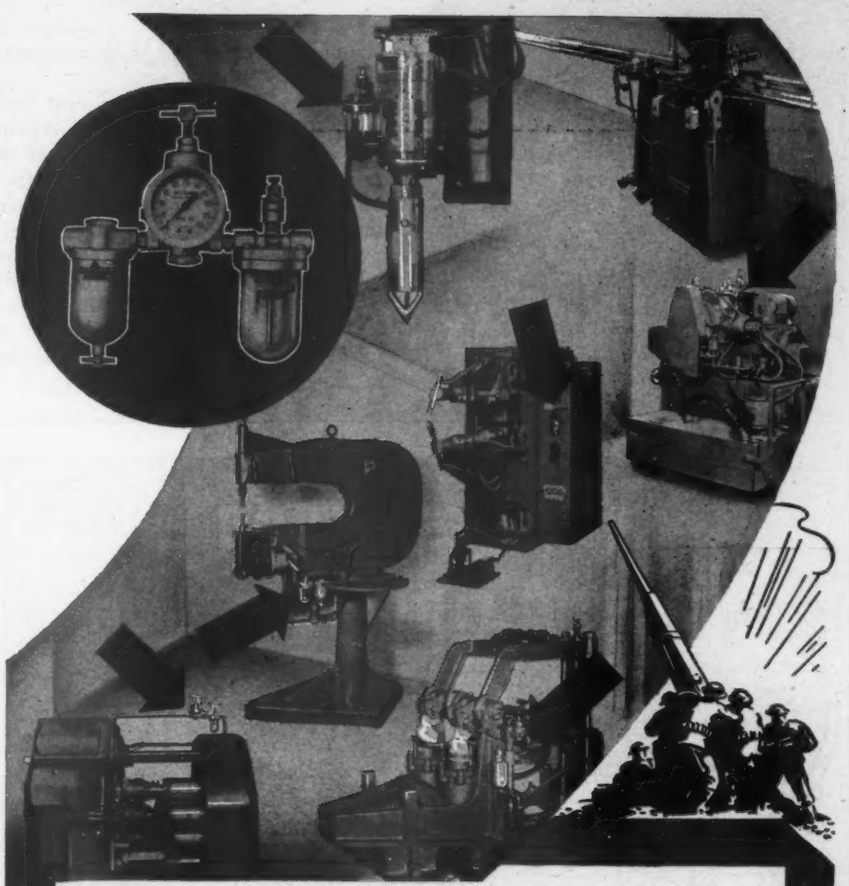
In teaching United States technique to British personnel the RAF and Ministry of Aircraft Production have spared no effort to clarify verbal instruction with working models and accurate perspective drawings of more intricate assemblies and mechanisms.

In the school section of this depot there are large panels showing the workings of electric and hydraulic landing gear retracting mechanism and flap operation, with sectioned rams and valves, etc., so that even a dumbbell engineer can figure out their means of functioning.

The Bendix-Stromberg injection carburetor differs a whole lot from British carburation ideas, and there is a special section dealing with this complicated component. Incidentally, the RAF have many jokes about the injection carburetor because of its many external gadgets, but, nevertheless, it is generally appraised for doing a great job.

Both Curtiss-Wright and Hamilton Standard propellers are explained in minute detail by expert instructors and there are full-scale working models built in mock-up frames alongside of which are sectioned hubs and sectioned components of the control mechanism. The whole job is so beautifully set out and the drawings so carefully and cleverly carried out that even the auto-service hand, who has spent his time pulling Buick motors apart, can very soon understand the intricacies of these propellers.

The motor training section is a marvel of efficiency and perfect layout. The three American motor types *Wasp, Cyclone* and *Allison* are all segregated and the various parts laid out in subassemblies, some of which again are sectioned. There are special demonstration exhibits of crankshaft and connecting rod assemblies, supercharger drive and clutch gearing, reduction gears, while special attention is given to cylinder and valve gearing in order to show the



BATTLE STATIONS

Air cylinders, air chucks, air tools and other mechanisms driven by air are making today's munitions production miracles possible. And there you'll find Norgren Lubrication—winning every battle against wear, corrosion, delays and break-downs.

NORGREN *Lubro-Control* UNITS

1—Filter the air; 2—Regulate pressures; 3—Create a fog of oil in the air stream which lubricates every working part against wear in use and against corrosion when idle. *Automatic:* work only when the tool works. *Fool-proof:* require no attention from operator.

IDEAL APPLICATIONS include use with air cylinders, air chucks, air tools, high speed bearing assemblies, and all types of air actuated mechanisms. Easily installed on air lines of any machine.

OVER 70,000 IN DAILY USE

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pressure lubrication system of the valve mechanism—a feature not found on British radials.

There are also sections and models of the forward mounted gear-box and extension shaft used in the *Airacobra,* while there are special examples to show the unusual accessory drive on the *Allison* V. 1710.

Another exclusive for the moment—American specialty, the exhaust-driven turbo-charger, used on the *Fortress* and *Lightning,* is shown in sections, so that you can immediately see the superfine craftsmanship employed in its construction.

Trainees are encouraged to visit frequently the large well-planned repair shops, so they can see what happens to motors, airplanes and components returned from service flying. Thus, after a few weeks of excessive training gaining first-hand experience of the various products, when turned over to the squadron they are familiar with any inherent troubles and know how to put a stop to many would-be difficulties before they actually arise.

High United States Army Air Corps and Navy officers visiting this country will do well to take a look at this training establishment—not that their problems back home are similar to those here, but a whole lot about training personnel can most surely be learned.

U. S. Aircraft at War

Since the last writing most of the *Fortresses* have left this country and for a short while they were being used on operations in Libya. The RAF have been a little disappointed in the *Fortress* as a considerable amount of trouble has been experienced with it, maybe due to many modifications too hastily carried out. This ship was unsuitable for service in Europe, due to its comparatively light armament, and when in Libya, I heard that it was experiencing trouble from operating in desert sand conditions. There are most excellent reports here about the new *Fortress* which will no doubt be used to drop heavy bombs in the European zone, when sufficient numbers of these planes are available.

The Douglas *Boston* has been modified and developed as a result of operational experience, and suggestions from RAF and Douglas engineers. Increases to armament have improved its striking power, while other improvements have boosted the performance, making it the fastest and most maneuverable machine in the category. Improvements will still continue to be made, and in the coming offensive it looks like the *Boston* will achieve a degree of fame similar to the *Hudson.*

Many engineers and fighter pilots here criticized the *Airacobra* when the first details of its design and construction were published. Pilots figured that the motor being behind them would cause instability and lack of maneuverability at high speeds, while they didn't like the idea of not having the protection of the motor in front of them. I have spoken to several men who have flown this aircraft, and all of them speak very highly of it, while Fighter Command give it the most excellent report.

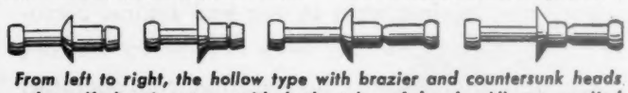
No details have been released about the *Mustang,* but it is rumored that it is as hard-hitting as the four cannon *Hurricane,* at the same time possessing comparable performance. I have seen the *Mustang* fly, and its remarkable resemblance, at certain angles, to the Messerschmitt 109 will give observers and spotters plenty of worry.

The RAF are very keen to get hold of information regarding the behavior, performance and bomb-carrying load of the Martin B-26—*Marauder,* airplane chief engineers are also very interested in this, on account of its advanced design.

Every plane built has its own hard-to-get-at spots for the riveter. Some can be worked on from one side only, with no possible chance to use a bucking bar.

Cherry Blind Rivets are made of aluminum alloy and are designed for this very purpose. They are highly efficient—have positive mechanical action—and do the job quickly and easily.

Closing tanks, putting down floors, fastening inside skin on corrugated sections, applying closing plates to the underside of wings, and scores of other difficult or impossible jobs for conventional rivets are easy and fast with Cherry Blind Rivets. Complete information on Cherry Rivets and their application will be furnished on request.



From left to right, the hollow type with brazier and countersunk heads —the self-plugging type with both styles of heads. All are applied with hand or power guns. The G-15 Pneumatic Gun is illustrated here.

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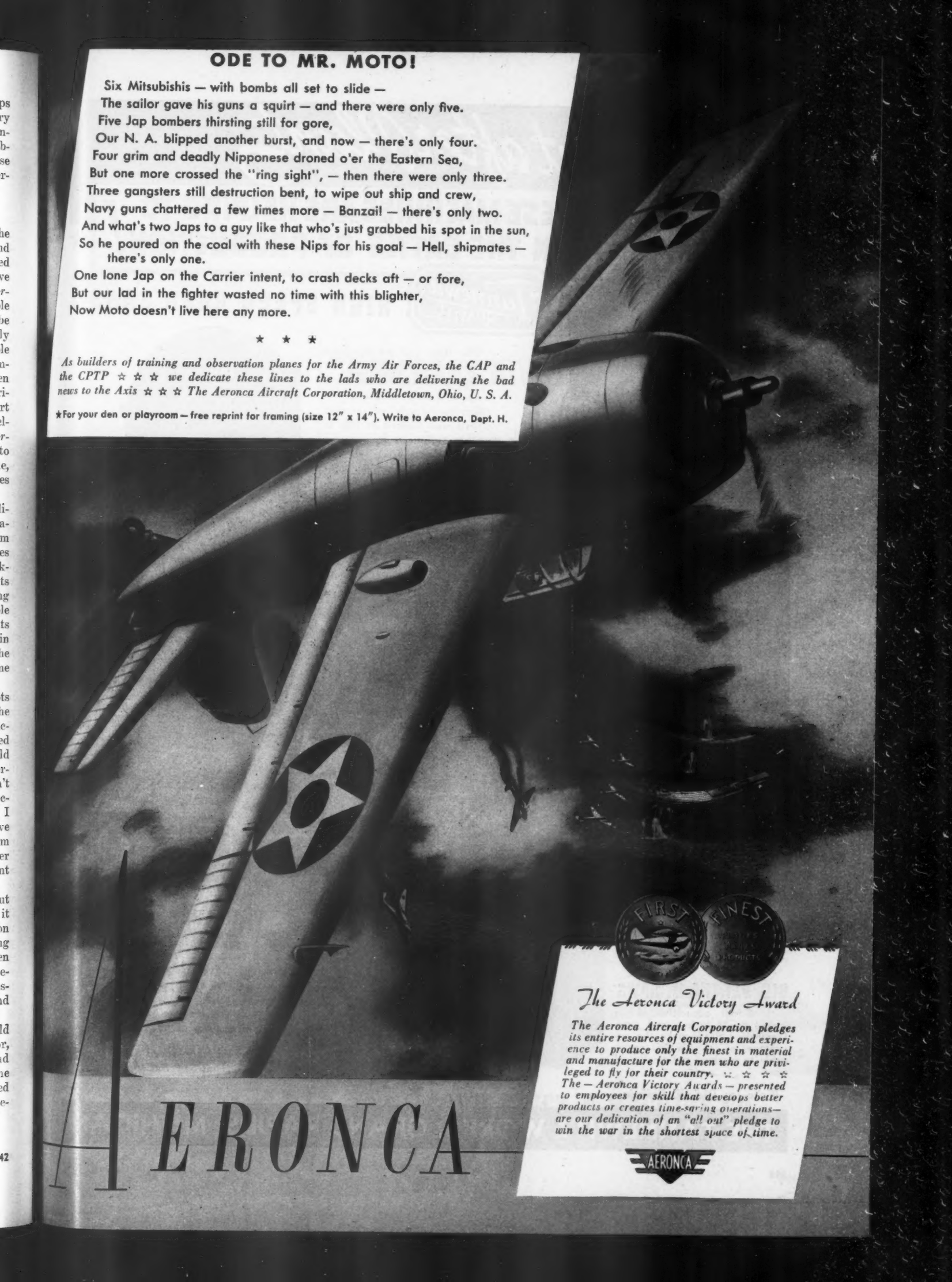

ODE TO MR. MOTO!

Six Mitsubishis — with bombs all set to slide —
The sailor gave his guns a squirt — and there were only five.
Five Jap bombers thirsting still for gore,
Our N. A. blipped another burst, and now — there's only four.
Four grim and deadly Nipponese droned o'er the Eastern Sea,
But one more crossed the "ring sight", — then there were only three.
Three gangsters still destruction bent, to wipe out ship and crew,
Navy guns chattered a few times more — Banzai! — there's only two.
And what's two Japs to a guy like that who's just grabbed his spot in the sun,
So he poured on the coal with these Nips for his goal — Hell, shipmates — there's only one.
One lone Jap on the Carrier intent, to crash decks aft — or fore,
But our lad in the fighter wasted no time with this blighter,
Now Moto doesn't live here any more.

★ ★ ★

As builders of training and observation planes for the Army Air Forces, the CAP and the CPTP ☆ ☆ ☆ we dedicate these lines to the lads who are delivering the bad news to the Axis ☆ ☆ ☆ The Aeronca Aircraft Corporation, Middletown, Ohio, U. S. A.

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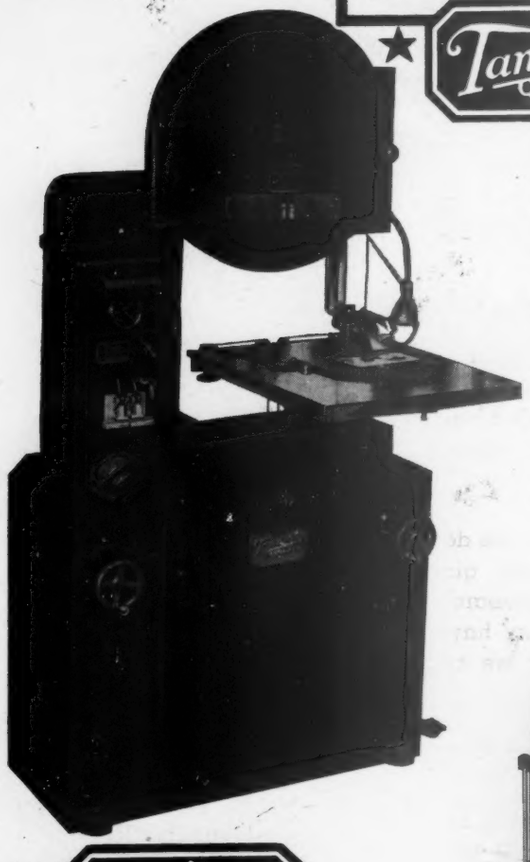
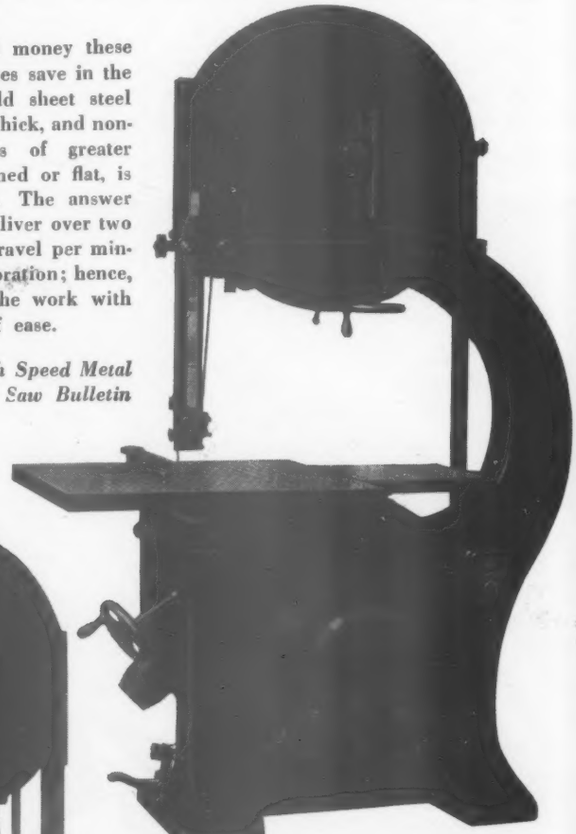


The time and money these superb machines save in the cutting of mild sheet steel up to ¼-inch thick, and non-ferrous metals of greater thickness, formed or flat, is truly amazing. The answer is that they deliver over two miles of saw travel per minute without vibration; hence, slip through the work with the greatest of ease.

Write for High Speed Metal Cutting Band Saw Bulletin



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with throat capacities of 36 inches to 48 inches, and even larger if desired, make the advantages of DI-SAWING applicable to work of practically all sizes.

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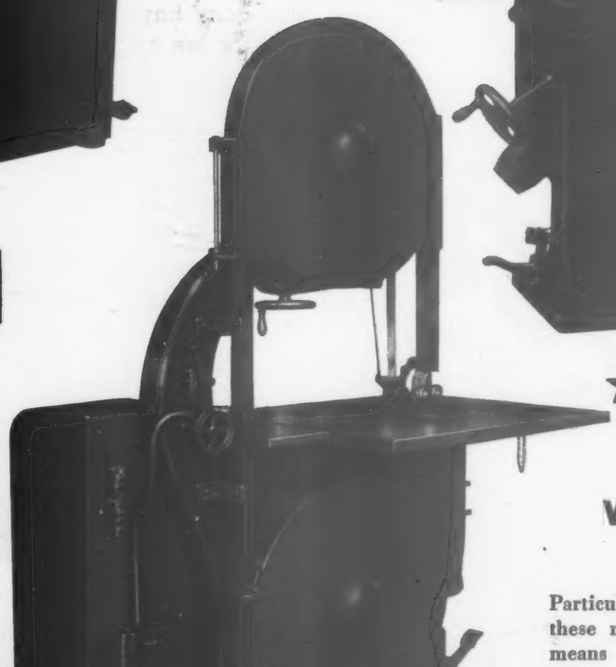

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Particularly advantageous for foundry use, these machines supply the fastest known means of cutting off gates and risers of castings of any metal. Available in sizes to handle castings of practically any size.

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THE TANNEWITZ WORKS, GRAND RAPIDS, MICHIGAN

Maintenance At United

(*Continued from page* 235)

are approved for return to service.

As the Cheyenne base now is operating, a 725-hr. overhaul requires about 48 hr.; a major overhaul, about five days. But speed, important as it is these days, is not the paramount consideration when it comes to airline maintenance. In the rush of wartime operations, as in the more normal pace of peacetime, nothing is overlooked or left undone when it comes to the exacting job of keeping planes in top-notch condition for schedules. Just as workers in aircraft plants are the men behind the men behind the guns over many distant fronts, so are the skilled mechanics and technicians of airline maintenance bases the men behind the men who are proving so essential in transporting wartime traffic on precious time-saving flights. Meticulous as ever, they are doing their job well.

Hitler's Latest Weapon

(*Continued from page* 243)

With this record, we would expect the Germans to use torpedo planes more than they have. The trouble with them in the past has been their lack of range. The two principal German models are only capable of 1,300 to 1,500 mi. round-trip, meaning that starting from a German base they cannot go far beyond the British Isles and get back. Then they are comparatively slow and unwieldy and thus a fairly easy prey to fighter planes.

Because the British Coastal Command has thousands of planes out on patrol daily, because radio locators and other means warn of the approach of planes near Great Britain and because practically all convoys have fighter or other plane protection when they near Great Britain, it has been pure suicide for torpedo planes to attack convoys near England.

Russian Convoys Vulnerable

The picture has now changed with the necessity of sending big convoys to the Russian Arctic ports on Murmansk and Archangel. Nazi torpedo carrying seaplanes can wait in the bays and fjords of northern Norway and attack these convoys as they go by. We have no place near Northern Norway where we can base fighter planes to protect the convoys. The only effective protection will be fighters based on small aircraft carriers, converted from cargo ships. It is probable that the cargo ships we are now converting to carriers will be used for this purpose.

There are two principal models of German torpedo carrying seaplanes, the He 115, made at the Heinkle factories near Rostock and the Ha 140, made by Blohm & Voss at Hamburg. The two planes are roughly similar, both two engine jobs of all metal construction, with a top speed of around 200 mph. They each carry one torpedo slung under the fuselage. In addition a number of German land planes can be converted to carry torpedoes and some of the landplanes carry two torpedoes each. The advantage of the seaplanes is that they can take off from any convenient harbor or bay. In places like northern Norway building landing fields in the rocky mountainous country is a real engineering problem, although the Germans have built a number with forced labor.

The probabilities are, then, that we shall have a plague of these torpedo carriers this summer and we may expect them wherever we are not able to provide fighter protection against them.

"AIRCRAFT RIVETS BY MILFORD"

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An Announcement

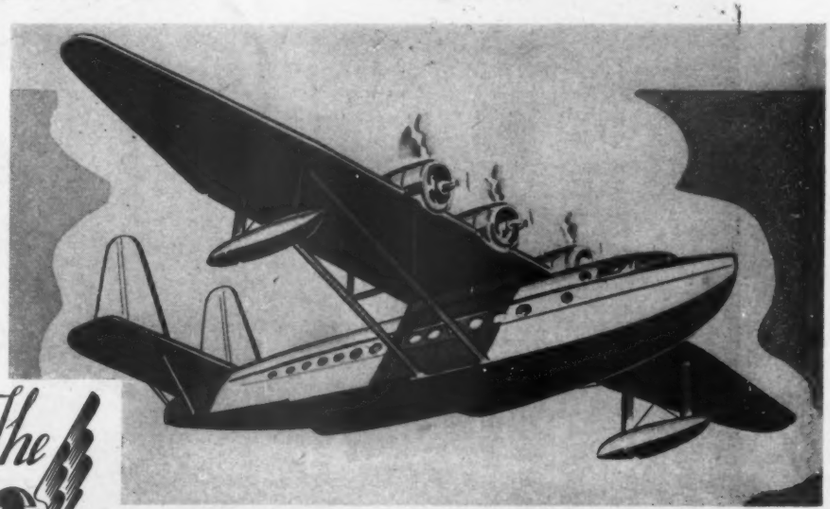
Since the first "Clipper" blazed headlines in aviation history, MILFORD RIVETS have been identified with airplane construction.

Rapid as has been the development of this young giant industry, Milford research and production capacity have kept pace, until today we can announce—

A PRECISION PRODUCT of highest quality throughout made possible by complete control within our own plant of all manufacturing processes, including heading, heat treating, anodizing and staining.

MASS PRODUCTION A plant newly equipped for quantity output with automatic machinery, operated by experienced man power, backed by knowledge and familiarity with airplane requirements; and. . . .

AWAITING YOUR ORDERS We are equipped to fill large quantity orders for solid or tubular rivets in aluminum, aluminum alloy, monel, brass, copper, iron or steel. Send for latest catalog and price list.



The MILFORD RIVET & MACHINE CO.

Post Road, Milford, Connecticut

Adapting Labor

(*Continued from page* 137)

The method of compensation is very important. Everyone starts at the bottom and gets a flat rate for 30 days. Without the added incentive of upgrading rates are increased at intervals of three months until at the end of a year the employee is getting 40 percent more than at the start. In the meantime if the operator shows superior capability the system provides for increases on a special merit basis. Whenever possible male employees are put on a piece rate basis so that they can capitalize their increase in skill. To make this system fair no cuts in rates are made unless the entire tooling and process on the part is changed.

Upgrading is encouraged, particularly for the men who show interest, application, responsiveness and ability to study. For these men there is offered an outside study course requiring three hours for 15 weeks. Great Lake College, a local institution, directed by Clayton G. Ettinger, Ph.D., its president, has carefully studied the machines and operations which are used in this plant, set up courses of instruction to suit the needs of the employees who want to increase their knowledge. Half of the tuition is paid by the company, the rest by the pupil. This has been found to give the best results. Twelve courses are now being taught twice a day, one in the day and the other in the evening so that both the night and day shifts may be accommodated. The subjects taught are: shop mathematics, shop theory, blueprint reading, metallurgy, foreman training, engineering principles, time and motion study, and tool and jig design.

Not only is the Woodworth plan a practical answer to the immediate problem of obtaining skilled labor, but it is a sensible approach to the vital objective of satisfactory and productive management-labor relations.

Blueprints and specifications were nothing new to J. C. Llewellyn who a year ago was a building supervisor for a real estate contractor, and who is now supervisor for the high production department.

The Woodworth company is highly in favor of women workers in operations such as high speed polishing where sensitivity of touch and clarity of perception are important.

Electro-Etching

(*Continued from page* 145)

was used. The results obtained are more uniformly dependable, and there is the added necessity that the developer be absolutely free from water. The presence of any water at this stage would be disastrous to the image as will be explained a little later.

After complete development—about 2 or 3 min.—the surplus developer is removed with a rubber squeegee. The plate is then thoroughly flushed with at least two applications of anhydrous alcohol at 200 deg. F. This serves a dual purpose: (1) It stops all action of the developer and removes its greasy film. (2) The plate is inked in the same manner as the original templet but this time with an etching ink which can be furnished by any photo-engraver supply house.

Applying "Dragon's Blood"

The plate is now placed in a large sink and flushed with cold tap water. It is important that the water is cool, as the ink will melt and run at a comparatively low temperature.

The colloid image which was hardened by the light exposure is soluble in water and washes away leaving the exact duplicate image of the original templet. The fidelity of duplication is sometimes amazing. Slight surface scratches in the original templet, hardly noticeable unless looked for, are picked up by the negative, transferred to the sensitized plate, and show up after the water rinse. These may be eliminated by painting out in a later operation.

TUBING for Radial Engine INTAKE STACKS*

*Tubing for aircraft engine intake stacks is but one of the countless types of special tubing developed by Summerill engineers in answer to the needs of industry

Official U. S. Navy Photograph

•

Intake Stacks by American Tube Bending Company

IN writing specifications for aircraft engine intake stacks there is no lowering of the industry's usual high standards. Requirements call for strong, smooth, thin-wall ducts with various combinations of short-radius curves.

Summerill Tubing specialists have developed an answer to this problem. They furnish specially processed low carbon steel seamless tubing in sizes of two inch and up, with wall thicknesses approximating 1% of the O.D. This tubing is supplied to fabricators who accurately bend it to the desired shapes on production equipment . . . at rates from one to two units a minute. In some cases the radius approximates the diameter of the tube, yet finished stacks are true and round, with no evidence of wrinkling or "orange peel." Another good example for the record of how Summerill Tubing is used to solve production problems.

Even though Summerill facilities and production are devoted 100% to the war effort, the experience and counsel of our staff of research engineers are available to you for the development of special tubing applications.

Buy WAR BONDS

SUMMERILL TUBING COMPANY
Seamless BRIDGEPORT Montg. Co., PA.
Affiliated with EDGAR T. WARD'S SONS CO. and COLUMBIA STEEL & SHAFTING CO.

HANSEN

INDUSTRIAL AIR LINE EQUIPMENT

● For over a quarter of a century Hansen industrial air line equipment has been standard equipment in large and small plants throughout the country. All Hansen industrial air line equipment is designed and built up in quality, not down to meet a price and renders efficient and trouble proof service far exceeding that of any other air line equipment on the market.

Hansen industrial air line equipment has held the leadership in the field on performance... producing outstanding results, saving time, effort, air and greatly increasing production at less cost.

Hansen air line equipment is used by the U. S. Army, Navy, large aviation and industrial plants where efficiency, speed, economy and dependability are an absolute requisite. Designed to meet today's production requirements and tomorrow's keen competition. Send for free catalog on complete Hansen Industrial Air Line Equipment.

1 HOSE CLAMPS
2 AIR BLOW GUNS
3 AIR HOSE COUPLINGS
4 HOSE CLAMP SOCKETS
5 HOSE CLAMP PLUGS
6 ENGINE CLEANERS
7 SAND BLAST CLEANERS
8 AIR-LIQUID SPRAY GUNS

Hansen MANUFACTURING CO.
1786 E. 27th ST. · CLEVELAND, O.

The procedure described produces a plate whose background is completely covered with a film of etching ink, leaving as bare metal only the scribed lines and stamping of the original templet.

The plate is thoroughly dried by blotting with a chamois and then an air blast. It is then dusted with "Dragon's Blood," a compound very common to the etching trade. This is a reddish powder, essentially resin, and it adheres only to the inked portions of the plate. This is to serve as an etch resist but it must be baked to produce a tough and durable surface to withstand the action of the electrolyte. Baking is done in an electric oven at a temperature of about 500 deg. F. for about 10 min. or until the ink and Dragon's Blood are fused together. The back of the plate is brushed or sprayed with an etch resist coating of shellac, asphaltum or plastic. The plate is now ready for etching.

Etching

The machine in which the etching actually takes place resembles the ordinary electroplating tank. It differs in process however, in that the work becomes the anode or the positive pole. Lead sheet serves most satisfactorily as the cathode since it is unaffected by the action of the electrolyte. Many experiments have been made with various kinds of electrolyte but in the end sodium chloride, or common table salt, was adopted. A concentrated solution gives the fastest results and coarse grained etched surfaces. This is entirely satisfactory for general templet work but if finer grained etching is desired it can be obtained by diluting the solution with a resultant increase in etching time.

The plate being etched is removed from the tank after about 5 min. and it will be found that the lines and stamping have been etched to a depth of about 0.005 in. This depth of etch has been found to stand up very satisfactorily under rough shop usage. These lines and stampings are now stopped off with the same etch resist, asphaltum varnish, which was used on the back of the plate. The plate is now completely stopped off except for the outline or external contour of the templet to be cut out. The plate is returned to the etch tank and remains there for approximately 40 min., or until the metal is completely etched through. If the plate is removed from the etch tank at the right time it will be found that the various templets are entirely cut through and are held together only by the tough varnish applied to the back of the plate. If the plate is removed from the tank a little too early it is necessary only to break the thin film of metal remaining between the templet and the parent plate.

There are many other applications by

STARRETT

At
VULTEE AIRCRAFT, INC.

Details of the Vanguard and the Vengeance are military secrets . . . but it's no secret that Vultee uses the finest precision methods. Here, a Vultee inspector is shown checking the location and alignment of guide holes in a large template with a Starrett Vernier Height Gage. Write for Starrett Catalog No. 26V.

THE L. S. STARRETT CO.

World's Greatest Toolmakers

Precision Tools . . . Dial Indicators . . . Ground Flat Stock
Hacksaws . . . Metal Cutting Bandsaws . . . Steel Tapes

ATHOL • MASSACHUSETTS • U. S. A.

STARRETT TOOLS

ARMY TWILL BY REEVES
REG. U.S. PAT. OFF. SANFORIZED
MADE TO GOVERNMENT SPECIFICATIONS

REEVES Glengarrie POPLIN

Demand these labels when buying uniforms

UNIFORMS OF REEVES ARMY TWILL CAN TAKE IT!

Pilots who fly in the service and ground men who service the flyers both demand uniforms that stand up under all conditions of work and weather. So insist these uniforms be made of *Reeves* famous fabrics.

Uniforms made of Reeves Army Twill meet exacting U. S. Government Tests for better wear, longer life, and color fastness. Its fabric vitality keeps it "in shape" under trying conditions.

GLENGARRIE POPLIN for matching shirts. A durable, stylish fabric that comes in a wide range of colors. Both fabrics are Sanforized* against shrinking.

*Fabric shrinkage not more than 1%. (U. S. Government Test CCC-T-191-a)

See your nearest dealer for uniforms, sport and work clothes made from these famous fabrics, or write for colorful leaflet to:

OVER 6050 million yards of Reeves Army Twill sold to the U.S. Army

REEVES BROTHERS, INC.
54 WORTH STREET NEW YORK CITY

which the etching process and its equipment can be put to use to reduce man-hours and simplify operations. Lithograph plates can be made for the printing department, name plates can be etched, and instruction sheets such as jig instructions can be etched into metal for permanency. However, its principal value lies in templet duplication.

This etching process fulfills the qualifications set forth earlier. It effects a material saving in time over the use of the vellum templet procedure. The templet duplications possess the following characteristics:

1. Exactness of scale. Duplicate templets are accurate to within 0.005 in. in contour and absolutely accurate with respect to surface lines.

2. Durable image. The etched image will withstand even greater abuse than the original because lines and stencilings can be etched to a greater depth than can be accomplished by the use of hand scribes and stamping dies.

3. Elimination of hand cutting. The templets are etched completely out leaving only a slight burr which is readily removable with file or sander. The time in the etching machine consumes no man-hours. Block templets are no longer cut and filed by the usual laborious method but rather the block templet line is scribed on the original layout templet.

4. The elimination of highly skilled labor. The described etching process can be taught to any one of average mechanical ability in a very short time.

5. Low initial equipment cost. A duplicating laboratory can be set-up to handle 4x6-ft. plates at a cost not exceeding $10,000.

6. Low operating costs. On a basis of group duplication using 4x6-ft. sheets, templets can be produced at a cost of less than 20c. per sq. ft., including chemicals, negative materials and labor.

AGAIN AND AGAIN
THE THIRD SC CONTROLLED ATMOSPHERE FURNACE
FOR A MANUFACTURER OF AIRCRAFT TUBING
● A leading company in the metal industry recently installed its third continuous controlled atmosphere furnace for annealing and normalizing seamless aircraft and other steel tubing. The first furnace, installed four years ago, has been in almost constant use.
Heated by means of gas-fired radiant tubes and employing a controlled atmosphere of DX gas, these furnaces are consistently producing a superior, more desirable finish as compared with the old method of annealing and pickling. And they are doing this at a substantial savings in cost.
The DX atmosphere gas is prepared in a separate generator by the partial combustion and subsequent refining of the fuel gas. Repeated tests have shown no appreciable decarburization on steel tubing up to .50% carbon.
Tests have also indicated that the temperature distribution is exceedingly uniform. Operating at a temperature of 1725° F. and at a capacity of 2000 pounds per hour, the maximum temperature variation across the hearth was found to be only 5° F.
Since in a continuous furnace with this uniform temperature distribution each tube receives an almost identical time-temperature treatment, metallurgical characteristics of each tube are also almost identical.
Write for bulletin SC-95A which gives detailed specifications and operating data on this and other similar furnaces.
SURFACE COMBUSTION • TOLEDO, OHIO
SURFACE COMBUSTION
MANUFACTURERS OF INDUSTRIAL FURNACES · JANITROL GAS FIRED SPACE HEATING EQUIPMENT · AND KATHABAR AIR CONDITIONING SYSTEMS

Tool Standardization

(*Continued from page* 152)

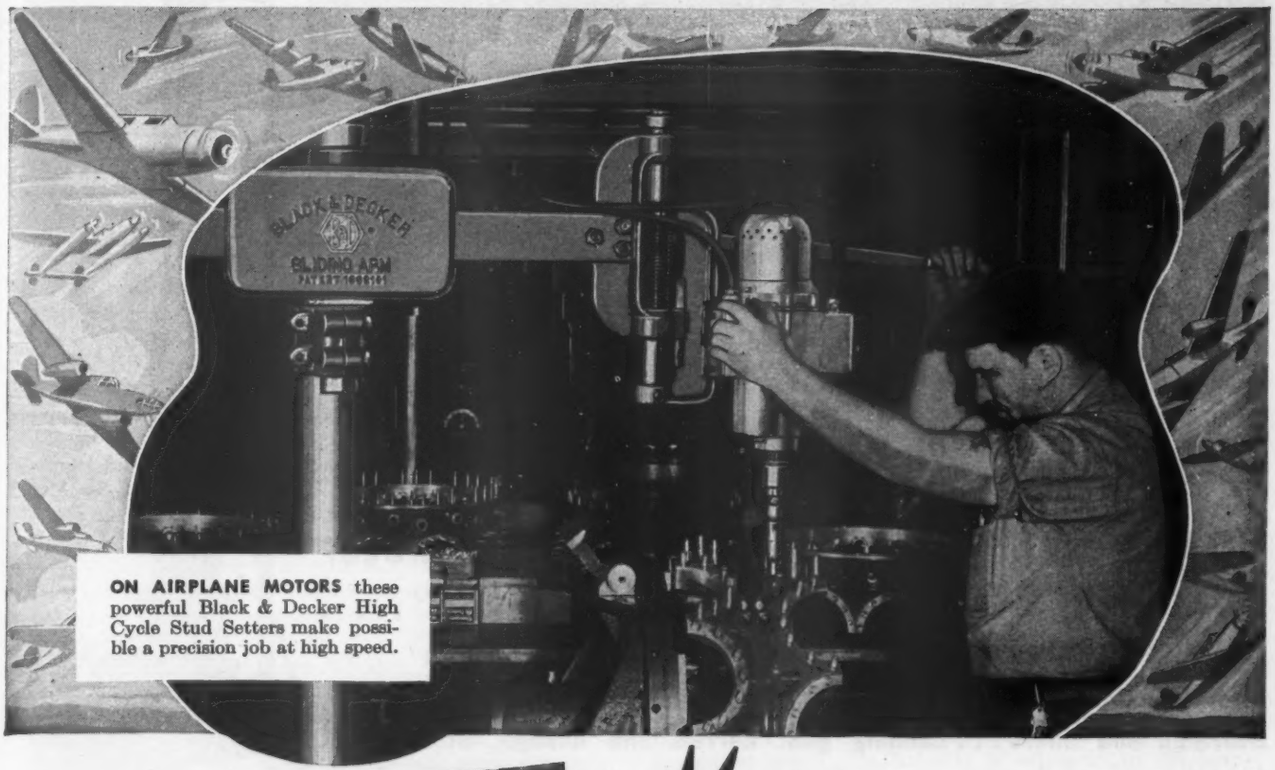
In early days, aircraft manufacturers were few and far between, each plant being in a different part of the country and not in close contact with others. Each manufacturer devised the type of tooling that would best assemble his own particular model of airplane. As mass production began to fit into the picture, and our new network of commercial aviation and communications was established, production was stepped up to such a pace that tooling became a vital problem.

At that time it was necessary for a tool manufacturer to keep on file all the prints from each aircraft company, and to accept changes in design or specifications as requested. This meant delays in delivery, short production runs on tools, duplication in inventory and generally uneconomical operations by both toolmaker and plane builder.

A series of conferences with tool designers was started, including meetings attended by representatives of principal manufacturers, to decide on standards that would be acceptable for the majority of tools. At the same time, the ideas and current developments of tool designers were discussed, so that the best features of each tool could be incorporated into a standard line.

The first line of tools attacked and standardized was rivet sets. Formerly sets were machined from bar stock and the percentage of breakage from fatigue and crystallization was very high. This breakage was found to be caused by grain structure, so a method of forging was investigated. After much trial and effort, a type of forging was developed that allowed the grain structure to flow and follow each radius. A special type of steel had to be developed for these forgings. This development proved very satisfactory and practically eliminated breakage.

The next problem was to develop a



ON AIRPLANE MOTORS these powerful Black & Decker High Cycle Stud Setters make possible a precision job at high speed.

HOLGUNS ON THE JOB, drilling on a wing-frame. There are over 30 models of Black & Decker Electric Drills for every type of drilling, aviation and general. They are powerful, fast.

GET PROMPT TOOL REPAIRS from the largest system of Factory-owned Service Branches in the industry — 26 of them, from coast-to-coast. Cuts "time-out" for repairs. Genuine factory parts.

More
BLACK & DECKER TOOLS
are used
FOR PLANE BUILDING
than any other

All along the aircraft production line—from motor to wing to fuselage to gun mounting—Black & Decker Tools do scores of jobs at top speed. More Black & Decker Tools are used in more aircraft plants to build more warplanes than any other type of portable electric tool! That's because they are *speed* tools!

Whatever tools you must have—drills, screw drivers, nut runners, shears, sanders, portable grinders (universal or high cycle)—they're all ready for you at Black & Decker. There are 120 different models. They're all husky for the long pull—they have the right feel—they're powered right for the job. Ask your Black & Decker distributor to demonstrate the tools in which you are interested. The Black & Decker Mfg. Co., 738 Penna. Ave., Towson, Md.

LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker
PORTABLE ELECTRIC TOOLS

A flexible machine that is the last word in simplicity of operation

HI-SPEED HONING and LAPPING MACHINE

for use with any standard make honing head

HONES CYLINDERS up to 24" in diameter . . . with STROKES from 20" to 72" . . .

IDEAL FOR AVIATION PRODUCTION JOBS INVOLVING:

Aircraft cylinders . . . Connecting rods . . . Supercharger parts . . .

Bearings and liners . . . Landing gear barrels and linkage, etc.

Speed up war work involving internal cylindrical surfaces by utilizing a HI-SPEED Honing Machine. When used with proper honing head of any standard make, the HI-SPEED machine produces accurate, straight, round, smooth bores—amazingly fast.

Unique positive stop and dwell system makes it possible to stop the spindle without shock or impact at the bottom of each stroke, at any point within the stroke range and hold the spindle without reciprocation, at that point up to 1½ minutes. Ideal for "blind hole" honing and straight line lapping or honing.

All controls are located at the front of the machine at the operator's station . . . No ladders to climb . . . Stroke setting, hone withdrawal, short stroking at any point, changes in speed of reciprocation or rotation of the spindle made instantly from operator's station.

The HI-SPEED Honing Machine is made in 4 sizes, any one of which can be had with strokes up to 72"...Designed for use with any standard make of honing head.

Tell us your requirements—and our engineers will promptly furnish you with complete information, prices and early delivery dates.

Illustrated is No. 0 Machine equipped for 36" stroke with 80" under the spindle.

NOTE THESE SPECIFICATIONS:

Model No.	No. 0	No. 1	No. 2	No. 3
Stroke (standard)	20"	36"	48"	72"
Working Base Area (standard) .. Auxiliary Tables available	21" x 22"	31" x 31"	31" x 31"	48" x 54"
Height Under Spindle Nose (up) .. Added Height Available on Order.	48"	60"	75"	100"
Spindle Diameter	2⅛"	2⅛"	2½"	2⅜"
Spindle Speeds Through Gear Box	4	4	4	8
Main Drive Motor (standard)	7½ hp	10 hp	15 hp	20 hp
Coolant Pump Volume, Motor Driven	14 gpm	18 gpm	18 gpm	25 gpm
Maximum Bore possible to hone with standard spindle drive motor	10" Dia.	12" Dia.	16" Dia.	20" Dia.
Maximum Overall Diameter of Cylinder possible to place on standard base	18"	27"	27"	44"
Floor Area	44"x60"	60"x80"	60"x80"	60"x108"
Overall Height	11'6"	15'3"	18'3"	23'8"

NOTE: Under our new policy of distribution, sales territories are being assigned to financially responsible, established dealers in the machine tool field. A few excellent territories are still open, and dealers are cordially invited to write us relative to sales representation.

AUTOMOTIVE MAINTENANCE MACHINERY CO.

2100 Commonwealth Avenue, North Chicago, Illinois

few standard lengths from the many hundreds then being used. Blueprints from the principal aircraft companies were gathered, as well as data from the Army and Navy. After much contact and cross checking, the many lengths were reduced to four standard lengths: 3½ in., 5½ in., 7½ in., and 10½ in. Cup dimensions were also standardized into one given dimension for each type of rivet.

The flush set next was standardized. Four types were selected, as follows: 3 in. length with 1¼ in. face; 6 in. length with 3¼ in. face; 3 in. length with 1⅞ in. face, and also a swivel flush set, 3¼ in. long with 1⅝ in. flush cup face with a rubber covering. The next part of the rivet set to be standardized, was the shank or gun end. Two sizes were developed; the first having a diameter of .401 with ½ in. radius on the gun end; the second being .497 with ¾ in. radius.

All the riveting guns that would not accept this new standard had their bushings changed over so as to accept this new set. These standards were found to be acceptable in 90 percent of the fabricating operations. The Army and Navy have accepted this as a standard, and so specify when ordering. Before this time, many sets had different radius, and required different riveting guns to handle them, thus, much time was lost finding the right set to fit in the right gun.

The next tools on our standard list are dimple dies. Much experimenting and engineering was necessary before arriving at any basic standards. It was found that angles on dimple dies had to vary, depending upon the thickness of metal to be dimpled. Four standard types of flush rivets are now being used, 100 deg., 110 deg., 115 deg., and 120 deg., with the first being used on the larger percentage of airplanes. The angle of the dimple dies varies with relation to the male and female dies; the male die being the exact angle of the rivet, with the female die varying 3 to 10 deg. more; depending upon the thickness of the metal to be dimpled. It is found necessary to use a high grade of tool steel for making dimple dies, also a forging process was developed to give them added strength. The need for extreme accuracy made necessary the grinding of both the male and female dies.

The next tools that came up for consideration were angle drills. It was found necessary to use several types and angles, such as a direct drive drill, about 6 in. long, using a 45 and 90 deg. angle, and a short nose dimension of about 1⅛ in. in depth; and a flexible type, using the same type of head as mentioned above, with the 30 in. flex attached. It was found necessary to make these drills of a gear driven type with a preloaded ball bearing head, with the bearing behind the gear of the nose shaft. These types have been accepted as basically standard, using a ¼-28 threaded nose shaft.

Many other tools such as, stop countersinks, back spotfacers, bucking bars, hole saws, etc., have been standardized into one complete standard catalog, using for reference by many aircraft companies.

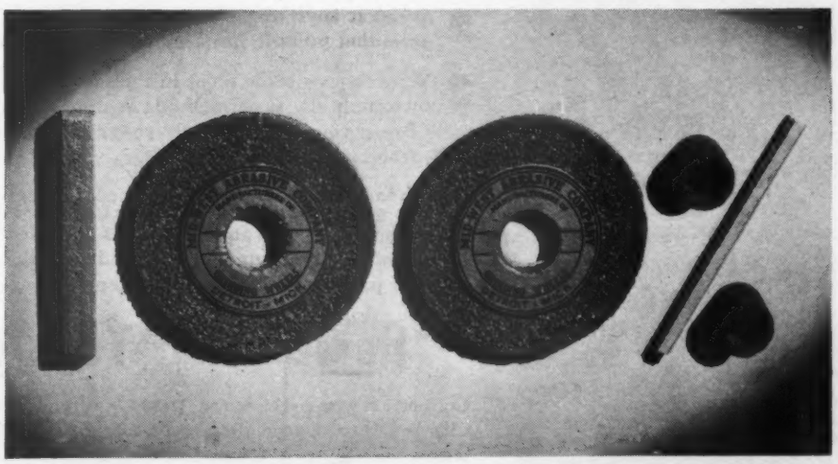
At standard's meeting, a suggestion was made to identify each tool with a certain size rivet, such as: Every tool used to work a $\frac{3}{32}$ in. rivet of any type or head, would be cadmium plated; every tool used on a ⅛ in. rivet would be copper plated; every tool used on a $\frac{5}{32}$ in. rivet would be Parkerized, which is a black plating; and tools for $\frac{3}{16}$ in. rivet would be brass plated. Larger rivets are unnecessary to identify, because of their size. Experiments are now being made with these four colors of plating to help speed production, for inexperienced workers.

Tool standards not only save time in obtaining the necessary equipment, and simplify ordering, but prevent working at cross-purposes. Where standards do not exist, one type of equipment could not be used on work started with another, specifications would vary from parts supplier or subcontractor to major, etc., resulting in delays, confusion and slower production.

As a matter of fact, the standardization of small tools is away out ahead of many other divisions of the aircraft industry. Although standardization has been widely discussed, and is now being put into effect as rapidly as possible, it is not as easy to establish standardization under emergency conditions as it was in peacetimes.

Now that practically the entire range of small tools needed by any manufacturer can be shown in one catalog, it is hard to remember that at one time every company supplied its own prints, and required tools to be manufactured to these specifications. The difficulties, delays and possibilities of error, as well as duplication of material and effort, have been greatly reduced by this program of standardization.

Such an accomplishment was possible, of course, only through the closest possible cooperation on the part of tool engineers and purchasing departments in the aircraft plants and other companies buying tools. That the program has been welcomed and appreciated by the industry is evidenced by the many endorsements of this campaign that have been received.



LIKE the English merchant who "Caters to the King," we are proud to announce that virtually one hundred percent of the guns being manufactured for the United States Navy as well as a large majority of those produced for the United States Army are honed with MID-WEST honing stones.

That is a simple statement of fact but to us it means recognition of excellency by our armed forces which more than justifies the many years of research and toil and training that went into development of these highly efficient stones. We contend that we manufacture the world's finest abrasives — honing and superfinishing stones, grinding wheels, emery cloth, sandpaper—and we submit that the selection of MID-WEST stones by our Army and Navy is ample proof of that claim.

The accuracy and fire power of our big guns, as our enemies are learning, are second to none in the world and the MID-WEST ABRASIVE COMPANY is extremely proud of its contribution to that prowess. May our guns continue to fire far and true and potently until those who would destroy our way of living are themselves destroyed conclusively.

MID-WEST ABRASIVE COMPANY

Manufacturers of grinding wheels, sandpaper and emery cloth.

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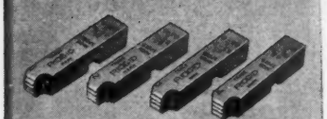
A New Service to keep your RIDGID Pipe Tools on the job



Dies for RIDGID No. 65R Series

Your RIDGID dies Factory Reconditioned **44¢** PER SET OF 4 Plus small shipping charge

Dies for RIDGID No. 1R Series

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FACTORY RECONDITIONING of RIDGID Wrench Jaws and Chaser Dies

Big Saving To You, New Parts Guarantee

No Priorities Needed

This Service available Only in U. S.

Here's What You Get

1. Careful inspection of the parts you send us, to make sure they are worth reconditioning. We reserve the right to reject them for service if they can't be made as good as new.
2. Wrench jaws to be scientifically annealed in our automatic electric furnaces, same as new jaws.
3. Wrench jaws to be recut in the same machines and by exactly the same methods as used for new jaws. Chaser dies are accurately re-ground to original specifications.
4. Wrench jaws are then rehardened, like new.
5. Both wrench jaws and chaser dies are given final inspection—and returned to you under regular RIDGID new part guarantee of satisfaction.

Here's What You Do

Collect all your old worn RIDGID Wrench Jaws and Chaser Dies and turn them over to your Supply House with order for this Reconditioning Service. Your Jobber ships them to us with parts accumulated from other customers, to save shipping expense, for we allow one-way freight to Jobber on lots weighing 100 pounds or more. Remember: *only* RIDGID *trademarked parts accepted for service.* No priorities needed. Service is prompt. Keep your RIDGID Tools on the job—order today.

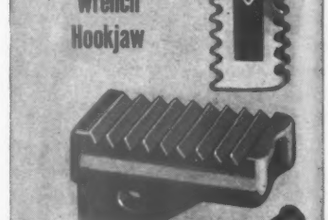
THE RIDGE TOOL CO. ELYRIA, OHIO

RIDGID

Pipe Wrenches, Cutters, Threaders, Vises

Your RIDGID wrench jaws Factory Reconditioned **1/2 PRICE** OF NEW PARTS Plus small shipping charge

RIDGID Wrench Hookjaw



RIDGID Wrench Heeljaw with pin

Work-Saver Tools for America's Big Job in 1942

Material Handling at Buick

(*Continued from page* 151)

the care required in handling aircraft engine parts.

Other parts received in the bond room receive correspondingly tender care. Any which may rust are dipped in a suitable rust-preventing oil, and those which may be marred remain in trays or are wrapped or otherwise protected against injury while being handled into and out of storage or standing in storage.

The bond room is devoted entirely to parts ready for issuance to final assembly and is divided into seven zones corresponding with the seven zones of the assembly department. This is to facilitate the delivery of the parts in groups or sets, precisely as they will be required in building the assembly. In the bond room there are three types of storage: Small parts are placed in trays or packages on shelves. Large parts are stacked between sheets of plywood in bins in the form of a cube, five feet on a side, but with front and top open. Parts requiring a special rack to avoid injury remain in the racks on which they are received.

Groups of parts required in each of the seven engine assembly departments are picked from bond-room storage and are set in special shelf racks or carriers mounted on trailers. These carriers are made with a space for each part or group of parts, that will be required in the assembly zone to which the carrier is to go and, when a requisition is received, loaded carriers are ready for the transfer. The carriers are spotted along the assembly line where they will be most handy for the assemblers. The parts, of course, are still separated in such a way that scratching or marring is prevented.

Engine Dollies

Engine assemblies are built up on special wheeled dollies having an engine mounting plate carried in trunnions and so arranged that the assembly can be tilted at any desired angle by turning a worm wheel with a crank. The circular mounting plate is grooved and supported by fitted rollers, making it possible to turn the assembly about its own axis. These arrangements make it possible to do the assembly at convenient height. Each dollie is on casters, two of which run in a channel track which keeps the dollie in the center of the particular assembly aisle. At the end of the aisle, the dollie is readily shifted to the next assembly zone and continues with the engine until the latter is completely assembled and ready for test, when it is lifted off the dollie and onto the next stand by means of an overhead trolley crane.

Subsequent to testing, engines are again placed on the assembly dollies and are removed to a department in which the assembly procedure is reversed. The engine is completely dismantled and every part is carefully inspected to make sure that no flaw and no significant wear has rendered the part unfit for use in the final assembly. After the inspection, the parts are placed in racks similar to those used in the first assembly and remain there until used again in the final assembly. Any defective parts are replaced before final assembly, but the others are built into the final assembly in the same way in which the initial assembly was performed. The parts are so marked that each major one occupies in the final assembly the same relative position it had in the first assembly.

After final assembly, the engine is again lifted from the dollie and is given a short run to make sure it is ready for installation in a plane. Having passed this test, the engine is removed from the test stand and is boxed for shipment.

Besides the parts assembled into engines, there are also produced a certain percentage of spares. The spares, however, are issued to a shipping department directly from the bond room and are packed for shipments in accordance with requisition for this purpose.

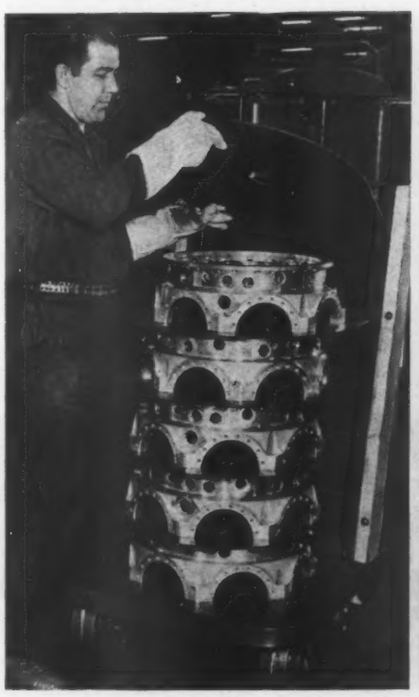
Scrap Collection

Although the foregoing outlines the general system of materials handling for production purposes, no mention has been made of materials which do not enter into the product itself. These nonproduction materials are received and stored in a separate department and, after inspection, are issued on requisition, much as in the case of production materials. They include cutting oils and lubricants and other processing and packing materials consumed in the plant. The storeroom issuing these materials loads them on trailers and, as loads are ready, semaphores indicating their readiness and destination are raised as a signal to the tractor operators to pick up the trailer and deliver it where it is needed.

Scrap and other salvagable materials also have to be collected in suitable containers which are loaded on trailers and delivered to a department concerned with salvage. There are also, especially in a new plant, new machines and equipment to be shifted and installed and this handling is also done in part by the trackless trains and in part by the fork and crane trucks.

As will be seen, the whole set of equipment is flexible in that it is readily adapted to variety of needs. It is also economical, since the trailers are moderate in cost and are not required in large numbers, considering the size of plant and the character of work done. Less than a dozen power driven trailers and trucks meet requirements and, though kept on the move, are economical in operation and in labor required. Much the same can be said of the other equipment employed. All of this indicates that the entire system is well planned and well operated.

LEFT: Special wheeled dollies for aluminum crankcase sections have hinged fiber board leaves for placing between forgings to prevent scratching of lapped faces. RIGHT: In the bond room bins for large parts, sheets of plywood covered with special paper are placed between tiers for protection of surfaces.



Work Simplification

(*Continued from page* 119)

workplaces and machines, although I know of only one or two defense plants in the country that are making use of this fundamental principle. Wherever it has been used, it has resulted in greater output, with far less fatigue to the worker.

Gilbreth developed four other basic laws of motion economy just as simple as this one, and which are constantly violated by almost every person who does any work with his hands. Most firms that have applied these principles have averaged 50 percent saving in time required to do a job. And when it is realized that these results have been secured by firms that have done a great deal in the past to improve efficiency, one can see how much greater will be the savings when these savings are applied to war production, which in most instances is brand new, and where little so far has been done to improve methods. One aircraft company recently installed a new method in its electrical department that reduced the time for one operation by 80 percent, and at the same time made the job much easier for the operator. A firm making radio tubes applied these principles to an operation and increased output from 13 tubes per hour to 60. These principles can and should be applied to every operation performed in making war material, and when so applied would result in substantially increasing the productivity of all those engaged in that work.

Progress Has Been Made

Walter J. Reuther has again repeated his claim that there was enough idle machine capacity in our automobile plants to build 500 airplane engines a day. His recent debate with Frank E. Wilson of General Motors brought out nothing new. While there may be some truth in the claim made by Mr. Reuther, and while the plan might result in putting some of this idle capacity to work, there is a far greater source of idle machine capacity. On the average, the machine tools used in armament production are not even 50 percent efficient.

Much of the progress in the automobile industry has been a result of overcoming this waste of machine time. To illustrate how they have done this, consider the improvement that has taken place in the motion picture theater. Nearly everyone will recall the good old days when every 15 min. the houselights went on, and a slide was flashed on the screen. "One moment, please, while we change the reel." Then each theater had only one projector and the operator had to crank the machine with one hand, while he kept the arc light properly adjusted. This was hard work, and you could not stop the machine to change hands. I recall the day when I graduated from the rewind bench and was allowed to run the projector myself while the operator went around the corner for a beer, and I remember the time when I finally was able to run both the machine and the rewinder. Today even the smallest theater has at least two projectors, and gives a continuous show, so perfectly timed that the audience can not detect the change over from one reel to the next. No longer do blue and yellow ghosts chase each other over the screen. The carbon arc is automatically controlled and the operator has plenty of time while the picture is showing to rewind the film on a power-driven machine.

And yet, this principle is rarely understood by either management or the workers, and as a result in most plants one finds the operator busy while his machine is idle, and vice versa.

Amazing economies have been effected by firms that have trained their people in this fundamental and it is not at all unusual for a plant or a department that is supposedly operating at maximum capacity of its equipment to secure another 25 or 30 percent increase in output. Contrary to the general impression, this is not the speed-up and in my experience I have found that most American workers welcome the chance to do a real day's work. I have had hundreds of them tell me that they did not enjoy standing around just watching a machine work. At an aircraft plant only a few weeks ago one man told the head of the work simplification department if they would give him another drill press he could operate that during the cutting time of the one machine he was normally operating. In addition, by improving the design of his fixture the whole job has been made easier, and at the same time has greatly increased his productivity.

Misunderstanding and misapplication of these fundamental principles have resulted in opposition by many unions to the "speed-up" or "stretch-out." And in most instances, they were justified, as it often meant that the workers had to work harder or faster.

This is probably a good place to stress the difference between work done at high speed, and work done in a hurry. Few people understand the true nature of this difference. *Work done at high speed will give perfect work, because it is accomplished by eliminating the unnecessary parts of the job. Work done in a hurry will give poor work, because it is a speeding up of all parts of the job, both necessary and unnecessary.*

Intelligent labor leaders have never opposed this method of increasing output.

If these principles are so simple, you may well ask, then why aren't they being more widely used at a time when we need and are trying to obtain maximum productivity.

We All Resist Change

First, we all resist change. We can understand the history of the world only when we give full weight to this emotional factor that is ingrained in human nature and makes us hold fast to what we have even while we reach out for what we hope may be better.

You may not think this is true of yourself, but you are quick to admit that it is a characteristic of everyone else. Try it out on your dog or cat. Start with him lying or sitting down. Push him from behind. What happens? All four feet dig in to resist this push. "All right," you decide, "if he doesn't want to go ahead, maybe he will go back!" So you push him from the front. Again, all his efforts are devoted to resist this movement. He displays the same instinct we do. Complacency, the feeling that everything is all right with the work, is a comfortable feeling. As long as we have this feeling, we remain inactive. When we fear that the comfortable state of affairs may be upset, we take action. Or, if it has been upset, we act to restore it.

Charles F. Kettering, head of the research department of General Motors Corporation, has said:

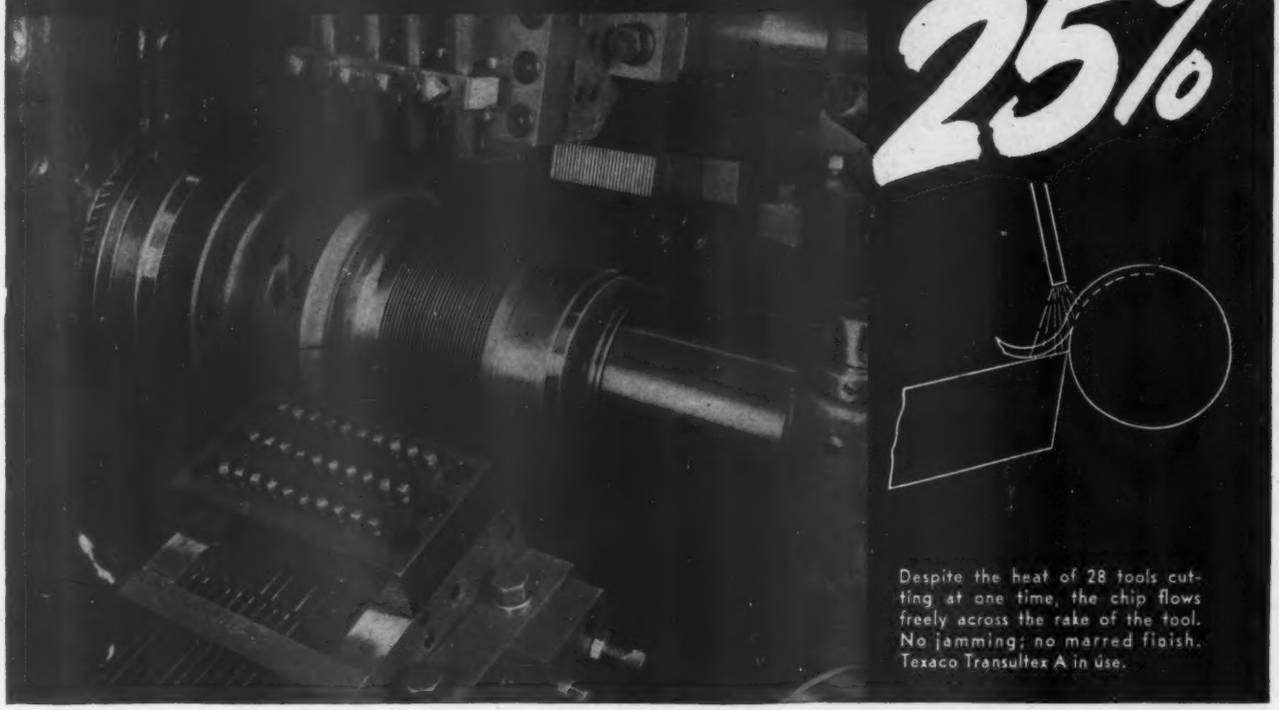
"The greatest durability contest in the world is getting a new idea into a factory . . . The most pitiable thing is a man who does not know how terrible factory organizations are. Putting a research man up against them is like throwing Daniel to the lions when they are hungry. The research man, after finding his problem, starts to gather up the information. By and by he will report: "This is what I have found out about the thing." And then when you read the report to the factory heads they say, "Applesauce!" and into the wastebasket goes the report.

"After all, that is a perfectly normal psychology. It never discourages me. I get to the wastebasket before the janitor. Soon afterwards I lay my report on the table again, and, if it goes into the same place, I get it again. After I have laid it on the table often enough the factory men ask to see the report. Then if one of them says, "Well, it does begin to look as though there was something in it, but I wouldn't do that —no, no!"—then I know I've got 'em."

One of the best illustrations of the resistance to the new is the development of Duco. Many years ago it took 37 days to paint a Cadillac car and 21 days

(*Turn to page* 313)

TOOL-LIFE INCREASED 25%



Despite the heat of 28 tools cutting at one time, the chip flows freely across the rake of the tool. No jamming; no marred finish. Texaco Transultex A in use.

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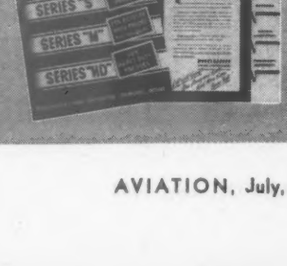
- New Armament Bulletin shows importance of springs for many types of war equipment.



for a Buick. As automobile production increased, it was perfectly obvious that something had to be done to reduce this time. Therefore a conference of the various paint experts was called. They spent all morning explaining to Mr. Kettering why it was absolutely impossible to paint a car in less time.

"Nature governs the drying time of paint," they said, and there just wasn't anything you could do about it."

Finally, after endless discussion, one of them, in the usual tone of an expert, said, "Mr. Kettering, if you know so much about it, how long do you think it should take!"

"Oh, about an hour," he answered.

Well, that settled it. They just knew he was crazy.

The meeting broke up and as they left, they were discussing among themselves the pity of a man making himself so ridiculous. "An hour to dry an automobile! Why the man is absolutely out of his mind." But Kettering was not convinced. He still thought it could be done. He believes that the only satisfactory place to stop is in front of the undertaker's office.

His perseverance was rewarded one day when he was walking down Fifth Avenue. In a shop window he saw a lacquered pin tray. Inquiry revealing that the tray was made in Newark, he immediately went there and told them he wanted to buy some of the paint. They thought perhaps that it might be arranged and asked him how much he wanted. Kettering said, "Oh, I guess about a quart."

"What in the world would you do with a quart." They asked "We never make up that much at one time."

"I thought I would like to paint an automobile door with it," said Kettering.

"An automobile? Why you can't paint an automobile with that," they said.

"Why not?" asked Kettering.

"Because it dries too damn fast."

And from that eventually came Duco.

You can well imagine how hard it would be for a worker to accept a new workplace like that on page 117. In the first place it just looks different from anything she has ever seen before. Asked to give it a try she uses new motions, perhaps has to use both hands instead of just one. And after trying it out for a day or so, she will have lots of sore muscles, and by that time she is sure that the new method is much harder than the old way.

To overcome the natural resistance to change, I have for years used with success a story I learned from Frank Gilbreth. Not so long ago we made a change in the method of packing rifles in one plant. This new method enabled the girls to sit instead of walking eight or ten miles a day, and to everyone it seemed much easier. After the girls had been on the job for a day, I asked one of them how she liked it.

"Do you really want to know," she asked me.

"Of course," I said.

"Well," she replied, "I don't like it. It's much harder than the old way.

So I asked the foreman if we could stop work for a few minutes. Taking out a stop watch, I asked this girl to write her name for me. It took five seconds. Then I asked her to write her name, leaving out every other letter. When she finally understood what I wanted, for it sounded like a crazy scheme, she complied.

"Ten seconds," I said. "You took twice as long to do only half as much work."

"Oh yes," she answered, "But I know how to write my name in the regular way."

Then she stopped. I did not even have to explain. The whole gang laughed, but they got the point. And in a few days they had that job clicking along in great order.

Increased productivity will mean using new methods, not doing the old ones faster. And that means we must keep this human failing in mind at all times if we expect to have people accept new ideas.

Next, we resent criticism. Remember that in the past most of the methods improvement work has been left to the expert. Either one or a few people in each plant are charged with the responsibility of seeing that these principles are applied, or it is left to some outside consultant. *These methods never have been and can never be successful.* In either case the worker as well as the foreman feels that his ability to do a good job has been questioned. Often the expert completely ignores the suggestions of the workers.

In one plant making food products a foreign scientist was hired to develop a new process. After working for months and spending thousands of dollars in the development of the machine, he finally gave up. The day after he left one of the foremen came to the plant manager and told him that he thought he could make the machine work. After spending less than fifty dollars he soon had it working successfully.

"Bill," said the plant manager, "Did you know this before?"

"Sure," said the foreman.

"Then, why in God's name didn't you tell the research man instead of letting

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him waste all that time and money?"

"I did," said Bill, "Right at the start. He asked me who I was and when I told him I was just the foreman here, he told me how famous he was and when he needed my advice he would call on me. So I figured, hell, let him find out for himself."

Now you can say that Bill was not loyal to the company and should have been fired, but the chances are that every one of us would react the same way.

Another instance of this was brought home to me recently when I visited a large foundry. The foreman of the core room was showing me around. Most of these fellows are prima donnas, as correct mixing of the sand used here is an art. He was proud of his department, his men and his methods.

"You know," he said, "They had one of them efficiency experts here last year. I guess the company paid him about $35,000, but he didn't get anywhere. He told me right off that they expected to make some big savings in my department. So he put three men in here. They worked for two months, but couldn't make any improvements."

And then he said something that gave me the answer as to why even capable engineers never could have made any headway in his department.

"Don't forget," he added, "I still had control over the sand."

Now, again, you may say that this man was not acting in the best interest of the company. However, he reacted as any normal human being would. I have never been able to understand why so few industrial engineers appreciate this fact. Credit is unique in that it can be acquired where none previously existed by the simple process of attempting to give it to someone else. It is one of the few things in life that we can give to others without possessing ourselves, and yet in the end we have just as much for ourselves as we gave away. It is surprising that more executives, supervisors and industrial engineers do not appreciate this fact.

Here is an excerpt from an issue of RCA's *"Beat The Promise* campaign publication (see page 74, AVIATION, May, 1942) to enlist the support of every single employee in finding better methods and eliminating waste:

Good Work

"The new mounting group was slow in coming up in production—the backlog was growing by leaps and bounds. The schedule promise has to be met—and, if possible, beaten! That's where Mary Lutwinink stepped in to do her part. Stan Gerar, foreman, knew that Mary was anxious but also knew that she had never mounted that type before. Mary got the job and in a few days the backlog was cleaned up, and a new record has been set for the highest production ever made by a single operator on that type. If Mary is proud she has reason to be, for she was ready when called to do her part."

And I'll wager that Mary has shown this article with her picture to everyone of her friends and acquaintances. All employees from the sweeper to the department head helped *"Beat the Promise,"* and when the three-month campaign ended 36,872 suggestions had been received. One of the big reasons for the success of this campaign, in my opinion, was the widespread and professional publicity given to those who contributed. United Air Lines saw to it that an award of $1,200 given to a mechanic in their Cheyenne shops for the design of a better seat-reclining mechanism received national attention.

Proper appreciation of these two principles is all that is needed to start a work simplification program in your plant tomorrow. Point out to your employees that they can't all join the fighting forces. We can't drop bombs unless we make and fill them; we can't fly the planes unless they have propellers and machine guns; and we can't shove a bayonet through a Jap's guts unless we make the steel.

Success in this war of production will come about only when we eliminate every source of waste of time, energy and materials. If we are to win, American management must couple its *know-how* with *show-how,* and make it possible for every worker to improve his or her own effectiveness. Darwin once said, "There are more people with adequate brains than we think, but they lack that quality of enthusiasm that is hard to define." American management must admit that it does not know all the answers. Give the workers a little help and plenty of recognition and they'll win the war for us.

Visual Training

(*Continued from page* 129)

cise as suggested above fail in many instances, because the new worker, confused as he is by the newness of his task, fails to visualize the way to do his job.

When the new worker has a properly constructed pictorial explanation of his job, he can see for himself what the work looks like as the various operations are performed—or pieces added to the assembly. In other words, he is able, mentally to obtain an overall pic-

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INSTRUMENTS • RESISTORS • SWITCHES

ture of the job from start to finish, and consequently attacks his problem with much greater confidence, and a much greater chance of doing it properly.

Visual training at Bell Aircraft includes enlargements of still picture studies of operations for the shop and service departments, motion pictures of both manufacturing and service problems, and slide films.

The present form of still picture studies as visual training material at Bell Aircraft is the result of a slow, painstaking period of development. The first step in the production of such a series of visual training pictures is a thorough study of all the operations involved in the performance of a single assembly or fabrication task. The visual training writer secures his first knowledge of the job from the detailed motion analyses furnished by the company's time study department. When he has acquainted himself with this material, he goes out into the plant to study the actual operations as they take place.

There, on the assembly line, or at the production machine he prepares his own operations sheet, noting which steps need to be included in the pictorial explanation of the task. In many of the visual training presentations, virtually every operation is pictured.

From the notes which he took with the assistance of the leadman in charge of the job being studied, the writer prepares a tabulation which contains a list of tentative captions for the pictures that he feels are necessary for the visualization, and a list of notes on just what he wants in each of the pictures.

The writer then takes a photographer out into the plant and the sequence of photographs is taken. Company photographers do the work, using Speed Graphics and view cameras as the case requires.

When the complete series of operations has been photographed, a sample set of 8x10 in. prints is made, and this set is studied, individually and collectively, to judge whether the desired production or assembly story has been told, with a minimum of extraneous material. The writer studies each picture to determine: (1) If everything shown is necessary to demonstrate clearly the operation; (2) if it shows the operation in sufficient detail; (3) what information has to be added in the caption to make the operation unmistakably clear.

The writer then applies a final test to the complete series, namely, asking himself whether the operation is explained pictorially as intended, in every detail, and without any confusing additional information.

Those portions of the picture which are not required to tell the story—such as a background, foreground or the worker's body other than his hands—

Rex-Flex elbow units for cabin heater conduit. 1½" I.D. with light weight adapter at one end and thick mounting flange at other.

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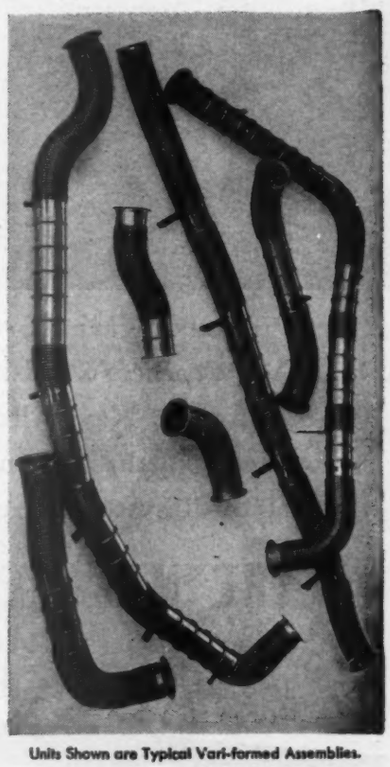

Units Shown are Typical Vari-formed Assemblies.

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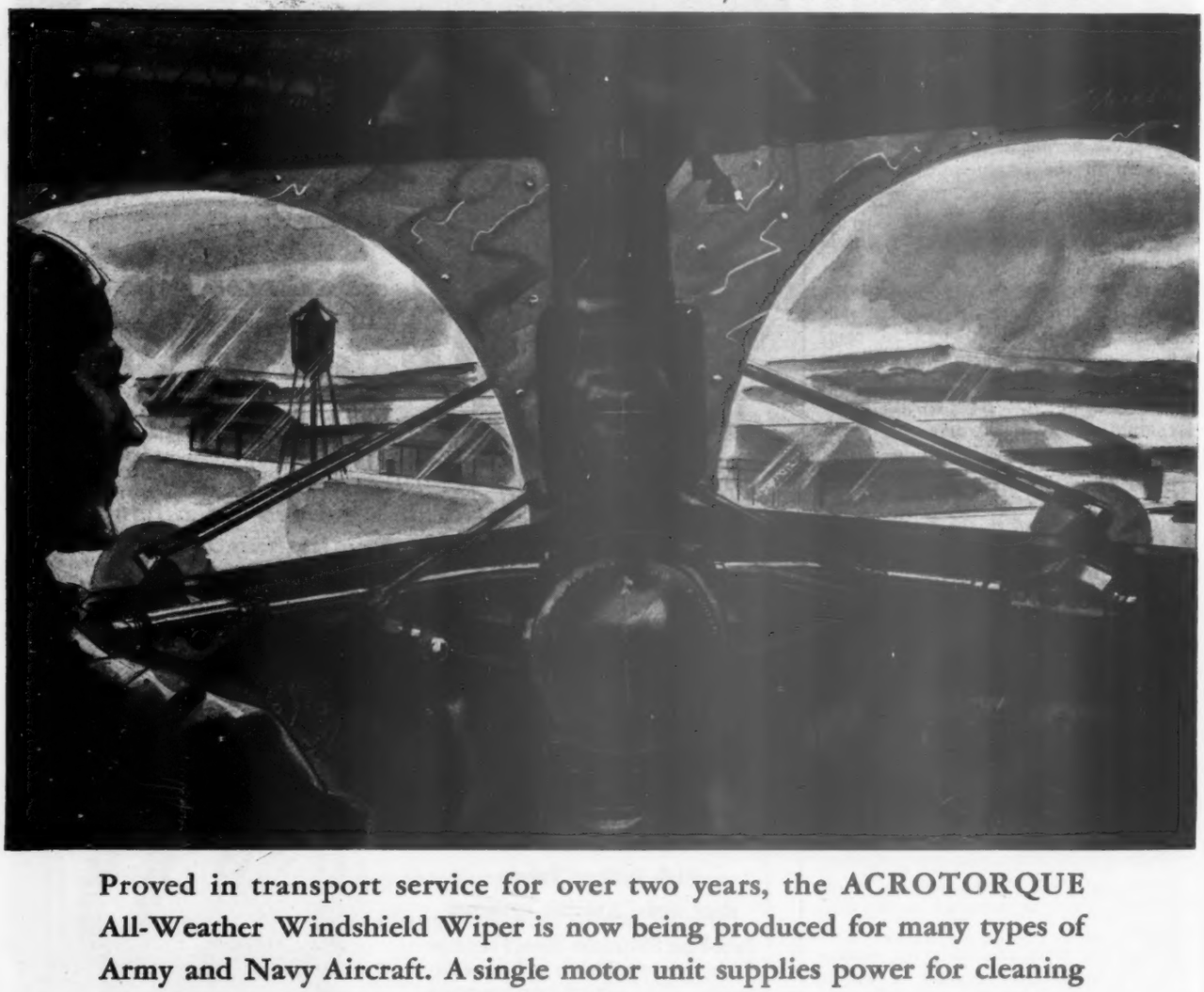

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might distract or confuse the inexperienced workman using the series for self-instruction, and so they are either removed or heavily masked.

If one detail of special importance is too small in the photograph to be entirely clear, it is marked to be enlarged as an inset in the final work.

The makeup of the series, including positioning of captions, etc., is a responsibility of the artist. He sets up the captions which have been furnished him together with part numbers, on a standard movie tilting board, and they are then photographed against the black background. The finished pictures are then printed using normal photographic technique.

A complete set of 8x10 in. prints is then made up for the writer, who takes them out to the assembly line, where he checks them for accuracy with department supervision. When the series has been checked, and necessary correction made, it is released for production. First a set of 16x20 in. prints is made up, and mounted on card stock. These cards are placed on suitable racks for display. These racks are taken to the factory department where the work is done, and made available for the use of the employees doing the specific work shown in the analysis. Additional books are made up, using 8x10 in. prints, and are furnished leadmen and foremen of the department. They are used for reference, and are often loaned new workmen as they are assigned to the job.

For the use of Bell Aircraft's service department, each set is made into a small printed booklet, measuring 5x7 in. Bound as a pamphlet, each is punched, so that it may be collected with others into a large volume. These small booklets are now being distributed in thousands to Air Forces personnel by the company's service representatives.

Visual training is one important contributing factor in the mass production of P-39 Army *Airacobra* airplanes and is greatly aiding in orienting and instructing new and old employees alike in the vital jobs they are doing for the war effort.

Lockheed Expediter System

(*Continued from page* 124)

a temporary, written confirming order would be sent to them. That done, department superintendents were notified of what had already been ordered, and the interested departmental offices were informed, in writing. In the routine of things, a day or two later, a permanent and officially confirming order came down from the offices. But in a matter of less than two hours a telegram was on its way to the War Department advising that the order had been complied with on existing, undelivered ships, and how it would be fulfilled on those to be manufactured.

Then there is the instance, some time ago, when some of our *Lightning* pursuit planes, stationed in certain, very hot, dry areas, developed front windshield cracks if allowed to stand so the sun shone directly on them for several hours. Being an expansion and design problem it was assigned to Expeditor E. D. Proudman, Jr., a graduate of Virginia Polytechnic Institute and loaned to us by our engineering department. His investigation report brought instructions from engineering to rebuild the curved, shatter-proof glass windshield in three sections. Working with the fabricators, he produced such a revision, ordered replacement quantities into production, and then turned his data over to Engineering where the change was incorporated permanently.

Under the pressure of our constant effort to step-up production, bottlenecks frequently develop in our subassembly plants. When that happens, Expeditor Edward A. Badia, who came to this staff from the experimental department, is sent out to locate the source of the trouble and effect a solution. His tact in obtaining the cooperation of those properly in charge has shown results so remarkable he automatically draws all such assignments.

On problems arising from the addition of new parts, such as a dropable fuel tank, Edward E. Gould, borrowed from our senior design engineering department, would "tune in on it"—one of our favorite expressions—and would "stay on the beam" until the problem was licked. It is his job, in many instances, to anticipate material shortages and delays in methods of fabrication, particularly on new development work, and perform liaison service between engineering, procurement, fabrication and other involved departments.

In the battle for air supremacy, which puts a premium on changes that step-up plane speed and hitting power and to ever increase production, problems arise that frequently make it imperative that we sub-contract something we originally intended to make here in our own plant. That means hunting up a shop that has the equipment and can be taught to make the part. Into such a case we would shove Robert W. Svihus, for five years a member of our experimental department. He is a practical

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authority on all phases of the P-38 and has been unusually successful in finding the right place to get a part made, up to standards and at the rate we will require them.

Quite early in its production, for example, it became necessary to go outside to obtain the needed volume of propeller spinners. Due to the unusually high speed and maneuverability designed into this pursuit ship, these spinners had to be both dynamically and statically balanced, as well as produced in quantity. Rejections sent Svihus on a search for a plant that could do the job right. It was considered too tough by one after another of the shops visited, but finally one offered to try it. By working with them for weeks, he finally established a source that has been unfailing.

Oldest man on the staff, in point of service, is Yale E. "Tommy" Thompson, who was one of the original expeditors selected back in 1938. A graduate of Texas A & M, in mechanical engineering, he is a member of the engineering staff and the one on who's shoulders falls a high percentage of this department's "hot ones" that require knowledge of design, mock-up, fabrication and assembly to solve. Typical of the jobs he does is a recent one from engineering.

A telephone call from the East coast informed engineering that after a certain number of hours of use, a bracket holding a recently changed vapor eliminator, had cracked on several ships. "Rush replacements and additional supporting brackets" the order to Thompson stated. That was 5 p.m. on Saturday. By noon Sunday the shipment was on its way. In the intervening hours he had drawn a rough sketch of an entirely new, supporting bracket, had a mockup completed, tools made, and the required number of the new part manufactured, and shipped, together with the replacement brackets. His rough design was then sent to Engineering where, from his data, the original bracket was redesigned to eliminate cause of the trouble.

The expeditor who most frequently works with Thompson is Jack A. Malone, with the company six years and loaned to us by the final assembly department where he was a senior group leader who worked on the first P-38 and all other Lockheed models. His knowledge of practical shop practices and his wide acquaintanceship and popularity with the staffs in all departments, when combined with Thompson's engineering connection and knowledge, make them a most successful team. Malone, however, like all of the others, also works alone on a majority of his assignments.

Naturally, this department could not function efficiently without a representative of the Tooling department. He is Reg. C. Alexander, who studied Law at Notre Dame and Loyola at Los Angeles, and was a federal bank examiner before starting with Lockheed in the experimental planning department, on the original P-38, later shifting to tooling.

Typical of the assignments he draws is the bottleneck that developed when, due to the slight, allowable variations on engine brackets to which removable cowling was to attach, it seemed almost impossible to make such covers interchangeable, as required by our contracts. Acting as both spark plug to push the job along, and liaison between engineering, manufacturing engineering, templet, tool, and tool inspection departments, Alexander followed through until the desired results were achieved. He investigates all tooling complaints, occasionally gets special tools made, even without an order, other than his own, and follows up tool manufacturing schedules when a job going through is needed in a hurry.

Wally Wells, another six-year man, from our outside production department, shoots trouble and breaks bottlenecks of all kinds in the plants of dozens of outside concerns doing subcontracting for us. Glen Cook, with three years experience in the engineering department, represents that department in field installation problems. And two of our men, Henry Brummel, from experimental, and Neal Thomas, engineering, are now on our overseas staff, having volunteered for such assignment.

As I mentioned earlier, the expeditor department functions on a 24 hour, 7 day a week basis. On night assignment is Kern E. Lovell, from the stores department and with the company five years. On those projects where work will continue from one shift to the next, and where its nature does not require the personal attention of the assignee, Lovell takes over and follows it through the swing and graveyard shifts.

This passing of the "baton" occurs almost nightly, but a recent example will illustrate how it works. A shipment of parts for new equipment being rushed to ships already in service, was being expedited through. Thompson had drawn the assignment one morning, in our regular eight o'clock conference. When Lovell came on duty it was not yet completed, so he followed it through, keeping in touch with the several departments involved, and before daybreak the next morning had the shipment on its way.

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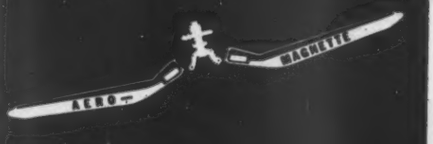

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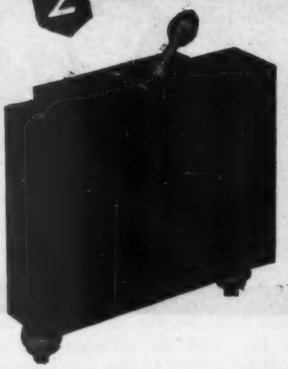

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Army Air Forces inspector, Joyn Biard, chief resident inspector for the Army Air Forces, and his assistant, Lawrence F. O'Rourke, and frequently draw assignments directly from them.

One unwritten restriction the entire staff strives consistently to keep within is that not over 25 expeditor tags are in the entire system at one time. Naturally we all try to keep those tags well below that limit, using them only when it is absolutely necessary, and checking back on each frequently to get it out of the system as quickly as possible, once it has been attached to an order.

Although cloaked with authority directly from the President Robert E. Gross and Vice-President Richard Von Hake, who is in charge of manufacturing, and fully capable of actually ordering changes in design, methods, tooling or anything necessary to break a bottleneck, expeditors are not looked upon as "glamour boys" by those with whom they work. Instead, and based solely upon the number and sources of the calls for assistance received by this department, their ability to solve a problem, get work done, and their willingness to work whatever hours it takes, is appreciated throughout our organization. So far as I have been able to learn there have been no complaints of high-handedness, abuse of authority, or efforts to hamper or discredit those in charge or doing the work in the department or on the production lines.

One policy they all follow, whenever that is humanly possible, is that normal systems and routines be followed, or altered the least possible, in achieving a desired result. However, if circumstances make it imperative, they follow that current new slogan—"In an emergency any intelligent, quick action is better than delay in search of the ideal." But when the emergency has been met, and corrections of a faulty system, design, process or method are in order, they approach the solution in the spirit of our company's slogan—"Look to Lockheed for Leadership".

Like the medical profession, that constantly strives to put itself out of business by curing the ailments of its patients, this expeditor department will no longer be needed when Lockheed humans and systems become perfect. But until that ideal is reached, a goal which now is constantly postponed by the demands of war, there is a seemingly endless need for such a group.

Multiple Shift Operations

(*Continued from page* 139)

Third shift premiums ranged from five to 10 cents per hour, with the average standing at 7.9 cents. More than half the replies showed such premiums were paid on the basis of an eight hour shift for from six and a half to six and three quarter hours' work.

By far the greatest majority of first shifts were reported to run eight and a half hours, with a half hour meal break —nutritionists' admonitions notwithstanding—almost universal. Starting times ran all the way from 6:30 to 8:45 a.m., with 7:00 and 8:00 most widely used. The selected companies without exception used either of the latter, with geography apparently the determining factor. In one case the two extreme starting times noted were used by the same plant for a split shift made necessary by traffic bottlenecks.

Other Shifts Follow

In most cases the second shift was shown to be the same length as the first, with the meal break again almost universally a half hour long. Also, as was the case on the first shift, meal breaks were staggered, sometimes over as much as two and a half hours.

In companies operating two shifts, the length of both first and second ranged from eight and a half to ten and a half, with half- and three-quarter hour meal breaks staggered up to two hours.

Third shifts ranged from six and a half hours with a fifteen minute meal break through seven and seven and three-quarter hours, both with half hour meal times, up to eight hours with an hour meal break.

Rotation of shifts, such as is common in some of the heavy industries, has not been adopted in aircraft production. Thus the problem of production lags caused by workers adjusting themselves to new hours of rest and recreation has not been encountered.

It is evident that night workers have adjusted their lives completely to work schedules, for no loss of efficiency or any marked difference in their general health records was reported. They also get their share of overtime and were reported to be as punctual about getting to work as those on the day shift.

In the matter of overtime, 75 percent of the replies showed it to be equally divided among the shifts, with the other 25 percent showing day workers getting from "a little more" to "almost all" the time over the scheduled 40 hours a week.

As to punctuality, two-thirds of the replies indicated all shifts were about equal, with approximately 25 percent stating that second and third shift workers are actually more punctual than day employees and but a little more than eight percent reporting them less so. The absentee ratio duplicated to a remarkably close degree the punctuality figures, both among the selected companies and the industry as a whole.

It should be noted, however, that some of the poorer day shift punctuality must be charged to transportation difficulties which are the fault of neither the employees nor the manufacturers. That transportation is a factor to be seriously considered as the industry expands is shown by replies which noted that some companies are already working on the problem; others which say it is "bothersome" and others which cautiously say it is "not yet" an important item.

Only in the matter of labor turnover do the night shifts drop measurably below the day, but even that difference has thus far presented no special problems. Some 44 percent stated that labor turnover was equally divided, but of those reporting greater shifting on the second and third turns, none indicated it was greatly in excess of normal.

No marked difference in the accident rate was discernible, for more than 60 percent reported it to be approximately the same on all shifts. In some cases either the second or third shifts were said to have slightly higher accident rates, but these were counterbalanced by an almost equal number—representing approximately the same amount of production—which showed the night shifts had lower accident rates. No pattern as to severity of accidents was apparent, for the reports indicating either of the night shifts being higher were very closely equalled by those saying the day shift was higher.

No labor trouble can be attributed to multiple shift operations for there was but one case reported in which night workers sought special privileges in addition to pay premiums. And in this case it was pointed out that no slowdowns, work stoppages or other production hindrances had resulted. Less than 20 percent of those reporting stated that union contracts contained special clauses affecting multiple shift operations, and most of these simply called for the premium pay rates which are common to the industry.

In no case have state laws deterred night operations, although in a few instances they have caused some additional expense because of higher pay rate requirements. In these states having laws restricting the employment of women on night shifts, authorities have in most cases granted special permits or waived the statutes pending amendments by state legislatures.

It is evident from the frank and complete answers of the companies cooperating in AVIATION's survey that America's aircraft producers have not only done an exceptional job of maintaining a high degree of efficiency while suddenly adapting themselves to multiple shift operations, but that they will continue on the same scale with further expansion which can only mean one thing for the Axis—bad news.

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B-24 Production

(*Continued from page* 103)

panels and bomb racks. However, many airplane components, made of sheet duralumin, are flexible and at present, it is not possible to eliminate all drilling required to mate holes during final assembly.

On the first of the second part of the line, the engines, outer wing panel assemblies, stabilizers and rudders are all added.

Fowler flaps and propellers are then installed with all the fittings needed for the wing and rudder control systems. The final stations are used to add the nose inclosure and radio instruments.

The entire side of the building is provided with large doorways so these large units can be brought directly opposite the stations on which they will be used. The 45-deg. angular placing of the planes on the line permits the storage of engines, propellers, empennages, flaps and turrets in the additional space thus obtained.

The underside of the carriage platform is provided with racks on which certain parts can be hung. For instance, engines come into the line already fitted with removable cowl panels. Since it is desirable to keep these panels with their own engines, they are hung under the platform and travel along with the assembly while the engines are being installed. Other detachable parts are kept with the plane in the same manner.

The opposite side of the building paralleling the first half of the line, houses a series of service shops. Among these are an armament room, used for preparing and sighting machine guns, a hydraulic and oxygen testing and inspection laboratory, and instrument department, an electrical test room, a tooling and methods office, several stockrooms and a toolroom where quick adjustments can be given templates and other tools without the red tape and delay that would result were such work sent to an outside department. Cribs, toilets and a first aid room occupy the space between the two halves of the assembly line.

A day foreman and a night foreman supervise the work at each eight stations on the line. Under each, eight leadmen have direct charge of each station. A placard hung on the side of each assembly gives the station number, the name of the leadman in charge and the name of the inspector.

Typifying the lengths to which mobile assembly has been carried is the installation of a portable shop clerk's desk on each carriage. Here the bill of materials and parts lists, as compiled by the tooling and methods department, are kept together with other essential shop records.

When an assembly reaches the end of the line, it is rolled out into the yard. Any final adjustments are made here. Air pumped into the oleo-struts lifts the plane from the carriage. It is then ready for engine and flight tests and for delivery to the Ferry Command.

When the assemblies are transferred from station to station signalmen stand on the wing tips on every eighth plane along the line. They have two flags, red and white. The red flag is the ready to move signal; the white one indicates that the line is in motion.

It is an inspiring sight—this column of giant bombers in motion at one time. Then the B-24 assembly becomes more than a production line. It is transformed into a parade—a parade that will lead to victory.

SAE-ESD Meeting

(*Continued from page* 107)

of shape causing air leaks and the subsequent engine failure.

Dual Oil Lines Suggested

Two suggestions were made by Karcher to correct this problem of air in the oil. One was to connect the rear scavenger pump through the oil cooler to the oil supply tank while the front scavenger pump fed direct to the tank through a separate oil line. Thus the oil, which will be solid during the climb and flight altitude, will be cooled while the oil returned during a dive or glide, which will be cooler, can be returned to the tank through a circuit of the minimum resistance. This will assure quicker priming of the front pump. This system would also tend to eliminate emulsifying the oil cooler passages and therefore improve its cooling qualities. A test of this system in the altitude chamber showed an improvement of 18 deg. F. at stabilization temperature and a gain of 30 lb. oil pressure with the original relief valve setting.

The other suggestion by the author was the use of a closed oil circuit duplicating the usual coolant system used on liquid-cooled engines. This would be provided with a deaerator ahead of the cooler which could be vented to a makeup oil tank floated on the pump outlet.

In the discussion which followed these two papers, Mr. Dolza explained to Mr. Withers of United Aircraft Products that in an hour's test when the oil temperature had risen 15 deg. and the oil pressure dropped from 72 to 60 lb. the aerated oil still had not stabilized. A very different result occurred when the oil was deaerated. The temperature stabilized at 84 deg. C. in 18 min. and the pressure at 100 lb. in 20 min.

L. A. Bryan of Lockheed-Vega asked something about character of aircraft limitations. It was explained by the author of the paper that where the oil tanks are behind the firewall restricted oil lines frequently caused overheating. The formula for best results is to *keep back pressure down and inlet suction up.* Using two coolers in parallel and streamlined fittings often will solve the problem.

To C. F. Bachlé of Continental Motors Corp., the following information was given. The average oil tank will get rid of 4 percent air when 30 percent full. The higher the level in the oil tank the better its aerating characteristics. The tank 30 percent full removes 4 percent of air but at 50 percent full it takes out 8 percent of the air. The best tanks are 18 to 24 in. high. Horizontal tanks are not satisfactory. A screen in the tank will also help deaerate the oil. The oil only remains in the tank about 1/10 of a second.

Suggestions were also made that a hopper tank be placed ahead of the oil cooler to get out the air. Also the question of using a centrifuge was brought up, but no one had any experience with these. Mr. Saunders of Harrison Radiator Co., called attention to the fact that cooling the air included in the oil greatly increased the heat load of the oil cooler and reduced its efficiency.

Jap Engine Exhibited and Described

The afternoon meeting over which R. N. DuBois of the Packard Motor Car Co. presided included the paper presented by W. G. Ovens, of Wright Aeronautical Corp. His notes covered the analysis of the Mitsubishi-Kinsei I radial air cooled engine. The parts of this engine were all on exhibition at the meeting and most of the auditors had already studied them carefully before the presentation of the paper. Mr. Ovens as a preliminary to the detail analysis of the engine made the following remarks about the design. "The group responsible for the design did a very ingenious job of combining what apparently they believed to be the most desirable features of a number of products of foreign manufacture—proven features all. These features are built into a composite design of the sort that 'has to work the first time' and probably did."

He added, "The manufacturing methods and equipment of manufacturers whose features were appropriated were probably used to produce parts of quality comparable to the originals. The available 'heavy industry' equipment probably influenced the design and finished parts which are peculiar to this

engine. In short, I am trying to convey the idea that this is undoubtedly a highly dependable, even though not highly developed, piece of equipment and that it was probably produced under time and tooling limitations which we would consider nearly impossible."

The detail investigation of the engine was carried out with the assistance of the materials laboratory and the engineering personnel at the Cincinnati plant of the Wright Aeronautical Corp.

The major dimensions and features of the engine are as follows:

It is a radial aircooled design with two banks of seven cylinders of 5.5 in. bore and 5.92 in. stroke. The engine diameter is approximately 47 in. The piston area 332 sq. in. and the displacement 1970 cu. in. The compression ratio is 6.6 to 1. A centrifugal supercharger 9.62 in. in diameter running 8.48 times crankshaft speed is provided. Estimated on a basis of using 95 to 100 octane fuel the engine ought to develop 600-650 hp. at 2,000. rpm., be rated at 850 hp. at 2,250 rpm. at 8,000 ft. and for take-off 1,050 hp. at 2,500 rpm. at 5,500 ft.

A detail analysis of each of the component parts as to design and material was given by the author. Also an excellent series of photographs illustrated what he did not tell about the engine.

In the discussion which followed the presentation of the paper, Arthur Nutt, chief engineer of Wright Aeronautical Corp., remarked, "We certainly have to respect an enemy who has incorporated the ideas which we have developed and are still using." He called attention to the condition and character of the bearings of this engine; also to the chromium plating of the cast iron compression rings. In his examination of the parts he called attention to the fact that some of the parts are very finely finished while some of the others are very crude.

One of the questions asked by S. K. Hoffman of the Aviation Corp., was, "How do they get away without a torsional vibration damper?" As no propeller was returned with the captured engine, it was impossible for the author to answer this question.

Huge Bomber Fuselage Trailer

Parked outside of the Rackham Memorial Building was a most interesting exhibit which had a crowd around it all day. It was one of the new Thornton trailers built to carry the parts of a bomber fuselage and wings. This unit is powered by a double engine tractor (two 100 hp. Ford V-8 engines). The drive is through a Thornton tandem axle. Another four wheel unit carries the rear portion of the semitrailer unit which completes the vehicle. The overall length of the whole tractor-trailer unit is 72 ft. 7 in. The load carrying portion of the trailer is 63 ft. 6 in. long. The overall height is kept down to 12 ft. 6 in. and the width measures 8 ft. 10 in. The sides are of steel but the top is of canvas so that the load can be placed in the trailer with an overhead crane. It is designed so that two of these trailer units will carry a complete bomber except for the engines. Seven railway freight cars are required to move the same load that two of these trailers carry. It is also claimed that these trailers can be loaded more quickly than a freight car, saving over 150 man-hours as well as all the dunnage.

Revealing Progress in Exhibits

The exhibits were very educational as some of them were examples of present practice and some indicated what we might even expect in the future. The first exhibit was the old Wright Brother's third four-cylinder engine built in 1904. Beside it was the 400 hp. Liberty V-12 of 1917 and close to that the Gnome rotary type engine used early in 1917. There was also one of the supercharged Pratt & Whitney Aircraft 18-cylinder engines. Next there was a mock up of the Ford supercharged V-12 aircraft type engine. This is the one that has the exhaust operated supercharger. Next to it was a two-cylinder test engine used to do the pilot experimental work on its design. The latest Ford V-8 tank engine was shown with sections cut away to give the engineers a good idea of the features of its design. This engine has a displacement of 1100 cu. in. and is rated at 500 hp. at 2,600 rpm. The Japanese engine, completely disassembled, was spread out on several tablese for the inspection of the visitors. Nearby, was a complete Mercedes-Benz inverted V-12 aircraft engine. It's crankcase was closed with a glass plate so that the interior could be examined easily. This engine has a displacement of 2,069 cu. in., develops 1,650 hp. at 2,500 rpm., weighs 1,263 lb., has 5.91 in. bore and 6.3 in. stroke and a compression ratio of 6.9 to 1.

A scale model of the B-24 bomber in transparent plastic so that the arrangement of the interior could be seen as well as the adjacent exhibit of a complete rear gun turret always had an attentive group of engineers.

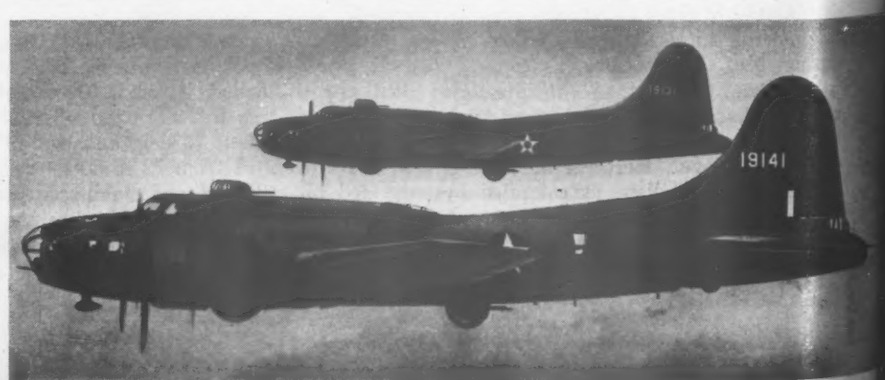
Plastics Release Aluminum Alloys

Use of plastics in place of aluminum in various parts made by the Ford Motor Company caused much favorable and interesting comment. Plastic map cases weigh 20 percent less than the aluminum ones made formerly and save that material for other uses. Air deflectors for the radial engine cylinders are now made from plastics and save 24 lb. of aluminum per engine. The bombardier escape hatch was shown, made from plastics, and not only saves the aluminum used before but is 20 per cent lighter.

Centrifugally casting the main landing gear pivot in steel replaces a composite design formerly used. It replaces 18 separate pieces formerly used. These not only required assembling but 15 ft. of welding. This construction not only saves time and material but weighs 8 lb. less than the composite unit. It is designed to carry a maximum load of 480,000 lb.

Two other interesting groups of exhibits were shown, one a cast steel crankcase for an 18-cylinder radial engine. This complete assembly of steel replaces aluminum forgings which weigh 377 lb. when they leave the forging dies. The center section in steel weighs 104 lb. as cast and 73 lb. when finished ready for assembly. The same aluminum forged center in the rough weighs 142 lb. and only 81.5 lb. when finished. This indicates the possible saving in aluminum and also in overall weight of the engine when the centrifugally cast crankcase is used. This is only one of the many examples of Ford steel castings shown. There were crankshafts and cylinders exhibited made from castings instead of steel forgings.

Saving Magnesium Foundry Scrap

Another series of magnesium castings, which are also centrifugally cast, were shown to demonstrate the savings obtained by the Ford methods. One rough casting which weighs only 49 lb. when the gates and risers have been removed weighed under the old method 144 lb. when removed from the mould but now weighs only 68 lb. Another piece used to weigh 181 lb. now weighs 106 on removal from the flask.

BRISTLING FORTRESS GUNS The formidable armament of the Boeing B-17E includes heavy calibre power turrets on top and bottom, a deadly tail "stinger" turret, and side mounted guns.